THE

QUARTERLY JOURNAL

OF

SCIENCE,

LITERATURE, AND THE ARTS.

VOLUME IX.

LONDON:
JOHN MURRAY, ALBEMARLE-STREET.

1820.

LONDON:
PRINTED BY WILLIAM CLOWES,
NORTHUMBERLAND-COURT.

CONTENTS

OF

THE QUARTERLY JOURNAL,

No. XVII.

ERRATUM.

Page 81, in the heading of the Paper, omit, "and on the Errors in Longitude produced by the action of Iron in Ships upon Chronometers."

TO CORRESPONDENTS.

The Editor is much obliged by the Communication signed N. L., and begs to know whether the Pyrometer therein suggested has undergone the test of experiment, since it is theoretically objectionable.

The Letter signed Boyle has reached its destination. The tube, if elastic, would be compressed by the exhaustion; if of metal, the obstacle would not close it sufficiently to answer the intended purpose.

We regret our inability to answer the Queries of C. A. H.

A New Edition of Mr. Brande's *Manual of Chemistry* is now preparing for the press.

CONTENTS

OF

THE QUARTERLY JOURNAL,

No. XVIII.

It is with the deepest regret that we have to announce the death of Sir Joseph Banks, who departed this life on Monday the 19th of June, between eight and nine in the morning, at his seat of Spring Grove, Middlesex, in the 77th year of his age. His loss will be severely felt in the scientific world, both at home and abroad; he had presided over the Royal Society for the long period of forty-two years, during which his zeal for the welfare of that body was unremitting, as it was successful.

TO CORRESPONDENTS.

Communications from the Earl of Mountnorris, from Mr. Jordan, Mr. Bowdich, and several other Correspondents, are inevitably postponed until the publication of next number of this Journal.

Our Correspondents are earnestly requested to forward their papers at least one month previous to the publication of the number of this Journal in which it is desired they should be published.

THE

QUARTERLY JOURNAL,

April, 1820.

Art. I. *Journal of an Excursion from St. Thome de Angostura, in Spanish Guayana, to the Capuchin Missions of the Caroni.*

[Concluded from Vol. VIII. p. 287.]

November 20th. OUR beasts being fatigued with our 14 leagues' ride of yesterday, halted, and merely rode to the tobacco-ground, about a league distant towards the north. Soil appeared rich and good, but the tobacco had been planted too late and wanted rain; yet the crop was pretty abundant, considering the want of hands. Had much conversation with the old overseer, and learnt, that for one rial per day, much more labour might be set in activity, as all would turn out for pay. At present, with much difficulty, twenty were brought into the field, who worked but half the day. Found this officer in rags, but quartered in a pretty little hut of *piná*, built by his own hands in a beautiful spot: the pay of his situation was formerly 70 dollars per annum; at present the government has nothing to give. On our return, passed the cotton-ground; it was weedy, but looked well and promised a good crop. It was an area of not more than from 30 to 40 acres. Palmar, the most eastward of these missions, is a pretty town, seated upon a rising ground, which seems to terminate on this side the plains of Pastora; beyond it the country sinks towards the level of the Orinoco. From this place it is said to be practicable to cut a path to the *Cano del toro*, the branch of the Imataca, which takes its rise in the mountains southward near

Cumamo. Was assured the Capuchins were in the habit of transporting their cattle by this route to avoid the duties of export; the path is closed at present, but was told by a person who had himself attempted it, that it might easily be opened again. This mission is certainly the best situated of any for an establishment; and Sedeno appears to think so, for he has settled his family and has a part of his cattle here, from 3 to 600. He has also held out the project of forming it into a town, and many Creoles have accordingly removed hither. All have, like others, suffered from the fever. The Indians of this mission, a mixture of Guayanos and Caraibs, have an excellent character for docility; but the fever and the want of proper supplies, have driven most of them into the woods. Counted 69 habitations empty, or nearly so; perhaps the intrusion of the Creoles has aggravated the desertion; the two castes never agree. Witnessed, for the first time, the evening service performed by the house-boys; about seven of them chanted the service in a careless catholic manner; few or none of the natives assisted. The church and conventual buildings are good and substantial. In the former is a well-executed image of the archangel Michael, shewn to strangers as a prodigy. The Residence has a garden and grapery exposed to the east; it was suffering much from want of rain: As we occupied the Padre's own apartment, took the usual liberty of rummaging his library, but found no records; nothing but theology, together with a list of the *Hiladeras*, (female-spinners,) who amounted to 417; there is reason to believe the missions contained more than appear in the returns: that of 1803 states this settlement to have been established in 1746, and to have had 817 inhabitants only. Amused myself at shooting on a sort of pond for the cattle; killed six wild-ducks and three negrocops; the rifle answered well for small-shot. On my way home, met the cattle returning from pasture; the cows, calves, and bullocks are always driven separately. Sedeno has judiciously obtained a grant of 2,500 head, part of which he keeps here, and the rest at Tumeremo. Palmar has no communication with Guayana Viejà except through Upata, which lies

nearly due west. A range of hills stretches away towards the SE., which is said to be connected with that running at the back of Guayana.

21st. Prevailed on M. to accompany us part of the way to Cumamo. Set out at day-break. Road S. by W. over undulating savannahs and through rich woods, affording beautiful views of the country. Rode briskly till we neared the *Potrero*, when we mounted a very elevated level, whence the distant mountains were distinctly visible. At about 6 leagues' distance, came to the *Potrero*, or breeding-farm for horses.— The mayordomo was absent; found only the woman and children in the house. Took possession, however, and resolved to breakfast on some wild hog she was barbacuing; it was excellent. For two rials procured the two hind quarters, on which the whole party feasted. This *potrero* at present contains nothing but mares and colts; it is advantageously placed and much resembles an English park; it is extensive and is fenced in, yet abounds in wild animals. Purchased a lion's-skin for two rials; the tigers'-skins were all gone. After an hour's rest, proceeded over similar ground for three leagues further, to San Feliciano, the *potrero* of Cumamo and Miamo; this place, being one of the stations of Sedeno's cattle, was inhabited by three or four families. It stands pleasantly upon a hill commanding a pretty view. The soil appears productive; milk and cheese abundant; in short, an excellent farm in the English sense. Roads diverge hence to Santa Maria, Miamo, and Cumamo. Took that to the latter, leaving M. who had sold me his mule for 45 dollars; considered her cheap, as she was a good beast in every respect, and kept pace with my horse. Four leagues more brought K. and myself to Cumamo over an improving soil. Rode up to the door, and found there two men with swords drawn and loaded musquets, in apparent anxiety; the family of the *teniente* alone remained, with an Indian boy and girl. All the rest had fled to the neighbouring mountains, and the troop of cavalry we had seen at S. Maria had not yet returned from pursuit of the fugitives. We had left our escort behind, and could with difficulty procure any thing to eat from our surly hosts;

but our numbers at length revived their courage. Cumamo is well placed, in full view of a lofty range of perpendicular hills, in which the Imataca is said to take its rise. Thither had the Caraibs retired, and a body of about twenty headed by the captain, when fallen in with by the detachment from Miamo, had killed fifteen of their pursuers; the women and children were supposed to be in the neighbourhood, deterred from returning by the fear of their more resolute countrymen. Could learn no other reason for this desertion, than dread of the conscription, and the natural preference of the Caraibs for a savage life. This was said to be the second or third time of their desertion. This mission was settled in 1767, and in 1803, contained 476 inhabitants. It is curious to note the slow progress of the monks; in the first year they baptized 12, in the second four, third six, and so forth. Marriages seem to have been less frequent here than elsewhere; in 1803 only 22. Did not hear of much havoc by the fever; but, on the afternoon of our arrival, a man and his sister came in from the woods, covered with the eruption of the small-pox from head to foot. With great difficulty prevailed on the apathetic manager to have them removed from the village to a neighbouring *conuco*. It was impossible to prevent the poor woman from suckling an infant at her breast. From the state in which we saw them, and the total apathy that prevails, have little doubt they were left to perish, though we took no little pains to excite commiseration. The grounds hereabouts appear good. Tobacco and cotton thriving; rice and maize in abundance; but, under the present system, in all probability the people will never return, and this beautiful mission be wholly abandoned.

22d. Started this morning for Miamo, after inspecting the tobacco-ground. Traversed a range of woody hills. Soil apparently very fertile. Took a direction westerly for about four leagues, and arrived at Miamo to breakfast. Resolved to leave my horse to recruit for a day or two, and picked out the best I could find from twenty belonging to the Commandant. Gave him his price, fifteen dollars. John bought himself a hammock for four dollars. Miamo was planted in 1748, about half a mile

from a stream, rising in the mountains near Cumamo, and running hither westward, until, emptying itself into the Uruguare, it turns southward into the Coyuni. This is the principal Caraib settlement, and in 1803 contained 920 inhabitants; the numbers have been greatly reduced by the fever, levies, and desertion; though the former was not nearly so destructive as elsewhere, there were forty sick. Silvas the commandant seems to keep the people in pretty good order. He had been in the employ of the Capuchins, and this is the only place that escaped plunder at the epoch of the revolution. He has occupied the younger hands in planting tobacco round his own place, which thrives well, and is of good quality. He rode out with us to the tobacco-ground cultivated for Government; it had suffered much from want of rain. This planting, of which I had heard so much, seems to have been delayed for want of seed until the rains were over, or far more would have been raised.—Discovered, in the course of conversation, that it was our host's practice to buy up all the colts and hammocks at a given price, 2½ dollars for the former, from three to four for the latter. The captain, a great breeder, told me of the contract and that I had been famously bit. This mission being in tolerable order, had an opportunity of examining a little into its œconomy. A *teniente* (lieutenant,) has the command, who has under him a mayordomo in charge of the cattle, and another officer, with the rank of serjeant, charged with supervision of the plantations; these three are Creoles. A captain, who seems in a manner hereditary, a lieutenant, two or three fiscals, and the master, artisans,—all Indians,—command their countrymen at large. One is always in attendance at the residence. The mayordomo has under him a certain number of men all mounted, whose business it is to bring in and take care of the cattle, and kill them when requisite. Each artisan has his assistants; the field-labour is allotted to the females, who should strictly work from sun-rise to four P.M., deducting two hours for meals. These people work alternately one week for the state, during which they are mustered every morning at the church, and the next retire to their *conucos* to

grow and gather their own provisions: but all hands are expected to muster on Sunday evening. The spinning and weaving is assigned to the girls, who are too young for field labour; these all work in the galleries of the conventual buildings. Being Sunday, attended the service at six P.M. All the young people were present, ranged in two rows down the church; the boys on one side and girls on the other. Silvas and the choristers read and chanted the service; all the rest joined in the responses. Near the end of the service, a procession was formed in the same order, preceded by the cross and banner, with six lanterns, and a hymn was chanted all round the town; the whole effect was good; 120 young Indians joining in a Christian service with much decorum, was a most pleasing sight. After the service, the unmarried girls assembled in the gallery to amuse the strangers and themselves with a dance. The men and married women never join in these diversions. Two old Indians scraped away on the violin, to whose melody bowed, with great regularity, entire rows of girls, with their arms locked closely about each others' necks. The dance consisted of two steps in advance, an inclination of the body, and then two steps to the rear. This was kept up as long as possible, and the point of contention seemed to be, who should bend the lowest and hold out the longest; being ranged two or three rows deep, the occasional contact of the noses of the rear with the hind-quarters of the front ranks was ludicrous enough. Our boys were soon laid hold of and locked in, each between two stout wenches, until bent almost double; nor was it long before the Dr. and myself, who hoped to escape on the plea of fatigue, were each of us carried off by two damsels, who, winding our arms about their necks, soon broke us into their discipline. The sport continued until about nine o'clock, when we retired to bed pretty well stunned, and much to the disappointment of our tawny partners, who hoped to have been escorted home. It was arranged that K. should remain behind, to perform an operation upon Silvas, until my return; and that my horse and two of our mules should be left to recruit, mounting Anisette upon another borrowed of our host.

23d. While waiting for the captain, who was to be my guide, went into the church to see the adults mustered previously to their being marched off to labour; they behaved with great decorum, though the seniors did not exhibit much faith in the ceremonies they were attending. The conduct of the patriots towards the priests must have abated their reverence for the religion. The number assembled was nearly 300. Silvas himself read the service. Set forward about seven A.M., and crossing the Miamo, took a S.E. direction over the savannahs, without any path. The sun was hot; we had no shelter, and certainly this was the most fatiguing ride of the whole journey.—Approached very near the base of a rocky ridge, when it suddenly breaks off southward; beyond is a vast woodless plain, abounding in good pasture, and appearing to stretch out eastward without limit.—Came to a brook time enough to bathe, before breakfast overtook us with the baggage.—Had gallopped on too fast to learn much from the captain in the way of conversation, except that the English were good friends to the Caraibs, and that Demerara had whole lakes of sugar and rum, and must consequently be a happy land. The wild Indians appear to keep up some communication with these people, as well as with our settlements. He seemed to consider the passage to Demerara practicable though dangerous.—Continued our hot and pathless ride, my guide steering for the hills, with all of which he seemed familiar.—Espied at length numerous herds of cattle grazing in every direction, and though shy, not absolutely wild.—It was three P.M., before we reached Tumeremo,—beasts jaded and myself thoroughly fatigued.—Had seen not a hut and very little shade the whole way. The hills were mostly of whitish marble, resembling quartz, whose ridges were sharp enough to have lamed both our horses. The padre was asleep, and it was with some difficulty I procured any refreshment.—Residence dirty and full of girls spinning; thirty were employed in weaving a splendid hammock for the chief. When the gentleman at length awoke, his urbanity of manner and sprightly conversation made amends for his apparent inattention. Dined as usual on beef and haropa, but very ill dressed. A mess of rice thickened the

porridge; his cooks were Indian girls that knew very little of their trade; his service consisted of two old knives and forks, three plates and some half dozen saucers, with calabashes to drink out of and pure water from the spring. Such is the seclusion and exile to which the Revolution has reduced this man, a relation of Bolivar, and once a wealthy proprietor in the Caraccas; yet he retained his spirits and good humour in this reverse, and was a staunch *patriota*, in other words, foe to Old Spain. His amusements are reading and sleeping, but he has, from want of any exercise, brought on a dizziness of the head that makes him miserable in the heat of the day.—Have often thought how usefully, if not agreeably, a man of talent might employ himself in instructing and governing so distant a community. Nothing is wanting but society. The natives here are healthy and well-disposed. Most of the men have been drawn off for military service; but the young and the women still remain, the fever having attacked here only seven men, who had driven cattle down to San Miguel. Cattle abundant. Government has here above 3,000, and Sedeno 1,100. Soil in the hills good; in short, nothing to be wished for but industry. R. is, however, not the man to introduce it. At sunset, 45 boys assembled in the church to sing the evening hymns; and at seven all the women came to evening prayers at the residence. Tumeremo was the last mission established in these parts; its date, 1788; proselytes of the Guayano tribe. Population, in 1803, 416 only. Houses single, and 63 in number. Church and conventual buildings built parallel and adjacent, but the latter too much exposed to the sun. Garden large, and containing excellent oranges. Here is also a tannery, and soap manufacture; but R. directs his efforts chiefly to the manufacture of hammocks; forty people have been employed two months in the making of two only. The extensive cattle pen, the posts of which have grown into trees, gives this mission a more lively air than the rest; and the contented cheerful countenances of the girls, form an agreeable contrast to what we had met with in the north.

24th. To recruit our beasts, and do honour to our host,

remained within doors studying Guayana with my pretty companions; the padre retiring, according to custom, to his hammock. Visited the plantations, however; found them in bad order and suffering from drought, but was much struck with the neatness of a plantain-ground belonging to one of the Indians. The tobacco looked ill, leaves small and worm-eaten; but the cotton seemed to thrive, though ill laid out. There were two kinds, the yellow blossom and the blue, the latter is reckoned the better, but being more adhesive to the seed, is always left to the private use of the Indians, who pick it with their fingers. Returning, met an Indian riding on horseback to his *Conuco*, his wife and daughters following submissively, with their tools, *&c.*, on foot. At present cattle is the staple product of Tumeremo. Besides those now here, 3,000 have been driven off to San Miguel. Soil about susceptible of high cultivation and well adapted to the plough, though not so rich as in some other parts. A road branches hence to Cura towards the S.E., which mission has been lately abandoned; it was at no great distance from the Coyuni, one of the tributary waters of the Essequibo, and was among the latest planted: its date 1782. Arechica and Currucuy, settled at the same period, have been also abandoned. The population of Tumeremo has been reduced to 286, *viz.*, men 36, women 125, children 125; that of Miamo to 405, *viz.*, men 25, women 250, children 130; the disproportion of adult males is very great, owing to the large drafts for military service. Cura, it seems, was abandoned only a few months since, most of the people taking to the woods: but the road is said to be still open. In the afternoon, the three men furnished for the expedition to the Imataca returned, reporting their failure in overtaking the fugitives, though they had found the bodies of the party slain in the pursuit. In these emergencies, each mission, it seems, is obliged to furnish its quota, armed in the best mode it can afford; one of these three had a musquet, the others spears, *&c.* Found in the garden many shrubs of *Carappa*, the seed of which furnishes an oil good for ulcers, and of a purgative quality. The Indians use chips of a turpentine fir for torches.

25th. This morning took leave of my Caraquenian host, and proceeded with a guide to Tupuquen. Entering the open savannah again, turned to the left, journeying towards the NW. across the southern side of the plain. Passed numerous herds of cattle and horses. They seem to have run wild for want of people to drive them in. Their general appearance would indicate the goodness of the pasture in these parts. Endeavoured to get a shot at a soldier-bird, but in vain. After a fruitless search for a spring, breakfasted beside a muddy pond, the water of which I had reason to think disagreed with me: this was the first time I had felt this inconvenience. Approaching Tupuquen, a distance of about nine leagues, the savannah improves in appearance. Saw large herds of mares grazing in different parts, with seven or eight mules. These latter seem to have been bred in the time of the padres, the people in office at present being wholly occupied in raising provisions for the Government. Tupuquen stands at one corner of this immense plain, at the foot of a ridge of mountains. Was planted in 1770 with Indians of the Caraib tribe, and in 1803 reckoned 570 inhabitants; now reduced to 150. The men have all retired to the neighbouring mountains, whither their wives are fast following them; and it is to be feared this establishment will be broken up before long. The stock of cattle is still considerable, about 4,000, mares 1,200, sufficient to form the basis of a colony. The cotton and tobacco-grounds are near and productive; buildings well placed and in tolerable good order, but mostly deserted. The old *Teniente* and his family received me with kindness; he seemed of very indolent habits. Towards sunset, took my gun and walked down to the lake or pond hard by, to shoot *wisissee* (ducks). Found them extremely shy. By hiding myself and sending the boys into the water, got a couple of shots; killed four, which, in spite of remonstrances, were forthwith dressed for supper, and as tough as you please.

26th. Procured a guide from hence to Carapo, seven leagues distant. Took a direction northerly, and crossed a range of well-wooded mountains abounding in *quina* and fine timber.

On the opposite side, entered some rich savannahs, where is a *potrero*. At four leagues' distance, came to the Miamo, which was nearly dry. A rude foot-bridge constructed of trees, and about 500 feet in length, shewed the occasional breadth of the channel. When full, it is necessary to dismount and swim the horses across. The road here branches off to the left to Uasipati, and the right to Carapo. Was welcomed by Cornejo, the commandant of the district, a clever intelligent man. Found him in a bustle, orders having just arrived to expedite 1,000 loads of provisions. All the Guariaiches were set to work forthwith to rasp *cassava* and make it into bread. They seemed diligent, and really got on with expedition. C. told me he thought he should be able to send off about 500 loads. An average mule-load is reckoned 200lb.; horse-load 150lb. Carapo was founded in 1751, is in the Caraib line, and contains sixty houses placed on an elevated spot near the woods. It should be healthy, but its frequent communications with San Miguel have introduced the fever. About forty were sick. Its general aspect is lively, from the number of trees in the garden, and the tobacco-grounds that surround it. These C. had planted on his own account, and they seem to thrive; he offered it me at sixteen dollars the 100 arrobas. Nothing is here grown for Government account but cotton and provisions. C. strongly recommended the project of renting a mission, and mentioned a spot between this and Miamo well-adapted for a tobacco-ground. The soil must be good from the appearance of the rice and maize, and of the cotton-trees; in fact, a range of hills lies close behind the town. K. came over in the afternoon drenched with rain. He had purchased a tame mule for twenty dollars, and a wild mule and horse for forty dollars: but left them all behind. Silvas had not been permitted by his wife to undergo the operation. The soldier's horse had been stolen, but my mules were reported all well. The Indians rarely steal mules, detection being more easy. In the afternoon, felt unwell, from the effects of the muddy water, as I conjectured. Took a strong dose of calomel in consequence, which confined me for the next day.

27th. Had much conversation with C. on the subject of a

settlement here. He was anxious to display the advantages, and assured me in the four missions I should find 500 serviceable hands. Learnt from him that the Uruguare runs past Cura, into the Cayuni; that he had himself descended the former in a small canoe, but found the latter so rocky and rapid, that he was afraid to proceed. The most practicable communication with the Essequibo must be by striking off to the Coyuni below the rapids; but the distance is considerable, and the Indian tribes hostile. Most of the runaways from the missions were supposed to have established themselves in that direction. At mid-day, were joined by Irvine the N. American commissioner, who had been making the tour in an opposite direction. He would not halt, but, after inspecting the cotton-grounds, proceeded to Miamo. His escort consisted of an officer and three soldiers, with a baggage-mule; he seemed somewhat disappointed in his expectations. Procured a fresh horse for our soldier, and borrowed one for John; and thus remounted resolved to set forwards next morning.

28th. Accordingly started early for Uasipati, two leagues distant across the savannah. Road good, broken only by one rocky rivulet. Arrived, after an hour's gallop. Proceeded immediately with the *Teniente* to the tobacco-ground. It was new ground just cleared and crop good. Was much pleased with the cultivation; leaves very large; plants looking well; soil hereabouts very productive. Cotton thrives well: the Indian *conucos* well stocked, and distant from the *pueblo* (village) scarcely a mile. Uasipati is the best situated and best built of all the missions. The church and conventual buildings large and substantial. It looks as intended for the residence of the general of the order. Indian houses oblong and rounded off at each end; much neater than any we had yet seen. The fever has penetrated hither, but dysentery seems the prevailing malady, and is probably a consequence of the fever. Over the church, found a sort of school-room, where a chorister was instructing five boys in the church service. Three of them could read already. The teacher was practising on the violin. Was assured there were three musicians; the principal one, who could read and write Latin, was

ill of the fever. Visited him, but could only give comfort and recommend bark. These musical gentry were nowise better fed or clothed than the rest of the people. Uasipati was founded in 1757, of the Caraib tribe: its population in 1803, 850, which number is now much reduced. It once had cattle in abundance, now the stock is reduced to 300, and between 4 and 500 mares. After a substantial breakfast, provided by our lively *teniente*, at noon pursued our journey to Pastora, where we expected to fall in with Uscategui. The road traverses an undulating savannah. Soon crossed the bed of a torrent, the Carichapo, very steep and rocky, Being nearly dry, met with no difficulty, but at times it was necessary to swim it. This torrent runs southward into the Uruguare, which afterwards joins the Coyuni. Advanced for 7½ leagues, in a line due W., across rich savannahs abounding in horses and cattle, and at three P.M., reached Pastora, gallopping most of the way to save our dinner. Velasquez, the commandant, welcomed us to his repast, consisting of beef, rice, and vegetables. Fell to with good appetite, notwithstanding the greasiness of the dishes. Found him a well-informed genteel man, ready to afford us every assistance and information. Pastora, or Yarnario, is built upon the banks of the river Uruguare, or Yuanrare, in the midst of a very fertile plain. It was settled in 1737, the fifth establishment in point of date, and served principally as the *Hato*, or breeding-ground of the missions. Judging from the prodigious numbers running wild between this and Puedpa, and said to exceed 100,000, it must have possessed considerable herds. The stock is now reduced to about 1,500, and 1,100 mares and colts. In 1803, it contained a population of 600. The houses were under repair; part of them new tiled, the rest thatched. Church and residence tolerable, but by no means equal to those of Uasipati.

29th. Spent the Sunday at Pastora. No morning service was performed at any of the missions. Matamoro's mule was missing. Anisette despatched in quest of her, but without success. In the afternoon Velasquez lent me a fiery young horse, training for Sedeno, and we rode out to visit the Labranza (tillage-ground). It is about a league on the other side of the

Yuarnare on the Puedpa road. A new piece of ground had been cleared for the purpose and planted with tobacco, cotton and plantains. All looked very healthy, as likewise did a field of rice. Cabbages and pines grew in perfection on each side of the path. In short, I had seen no ground looking so well. The tobacco large and well-flavoured. The drying-house outside of the enclosure served also for the habitation of the people during the planting season, it being too far distant to return at night. Partook of a water-melon and returned. V. much surprised at the English mode of riding. He had flattered himself I should be unable to manage his fiery steed, and tried my saddle, but soon dismounted in fear of his neck. Were much pleased with this man's skill in planting, also with his treatment of the people, whom he affected to consider as his children. We had brought a boy from Carapo, and bought him an old saddle for twelve rials. Procured here a new cover, of which many had been made for the use of the army.

30th. U. not making his appearance, rode over to Ayma this morning; distance seven leagues to the south. Crossing the Yuarnare at the ford, with the water up to the horses' bellies, turned off to the left before coming to the *Labranza*, and soon entered upon beautiful savannahs, skirted by lofty woods. Numerous herds of deer and wild cattle fled at our approach; they had been grazing in these delightful grounds. Might imagine ourselves in an English nobleman's park. A ridge on our left bore away to the south. About midway, crossed some rocky hills, whence we had a glimpse of Ayma in the distance. Being disincumbered of baggage, gallopped on briskly till near the place, when we slackened our pace to prevent the Guaycas from taking alarm. The people of this mission had fled when the levies took place. Many had since returned, and some been brought in by the Caraib horsemen from Carapo employed in this service, who had spread much terror and killed many of the fugitives. Passing a little brook, found this little town beautifully seated on an elevated spot nearly surrounded by the mountains. The buildings of recent construction, and in better taste than most that we had seen. The people were employed in making *enxalmas*,

(packages, or saddle-bags,) for transporting the corn and *cassava* required for the army. They are made of raw hides and a species of reed ; a knife is the only tool necessary for the manufacture ; others were twisting leathern ropes ; while two boys, who had suffered the sheep to run wild, were confined by a very simple contrivance, answering the purpose of a pair of stocks, *viz.*, a leathern thong passed round both their legs, and made fast and tight to the posts of the gallery. The grounds though much neglected in consequence of the recent troubles, appeared fertile. The cotton and tobacco looked well. Breakfasted and returned to Pastora. Note that the Yuarnare is rocky and rapid ; about 100 yards across at the ford ; course about S.E. ; water limpid. Dinner to-day so greasy, that it almost made me sick. Was obliged to take a cold bath before bed-time. U. had not arrived. My mule not forthcoming. Despatched Anisette to Santa Maria with orders to wait for me at San Antonio, thinking she might have found her way back to her old master. Agreed to start for Puedpa on the morrow, with V. in our company.

1st. *Dec.* Witnessed this morning the method of taming the wild horses. About thirty had been brought in with thongs about their necks, and were made fast to different posts. The gentlest were taken first, as an example to the rest. Each was first blindfolded, by drawing a leathern bandage over his eyes. After a little coaxing, a leathern thong with two buttons was next passed with some dexterity round the fore-legs, in the manner of a pair of irons ; if refractory, another is passed round the hind-legs. The animal is thus left to his reflections for half an hour, when the packsaddle is boldly fastened on, so that he cannot rid himself of it. His eyes are then unbandaged, and he is permitted to look about him. If he behave well, his legs are then set free, and he is suffered to caper about ; but left all night with the *enxalmas* on. Next morning his legs are again tied up, until he is loaded, and he soon finds his advantage in submission. Sometimes there is a little sport, but the rough usage of the Indians soon breaks them in. Started at seven. Direction a little to the north of westward. Traversed some elevated savannahs, in one of which there was a large cattle-pen.

The view extensive, but without variety, until we came to a shady brook, where we breakfasted. V.'s attention had provided a store of eatables, so we spread our sail on the ground and passed an agreeable hour, engraving our names and the date of our visit on the bark of the tree under whose shade we were regaling. Resuming our journey, found the plains improve in fertility and better watered. Crossed many brooks and swamps, that must occasionally be dangerous, all emptying themselves to our right into the Yuarnare, which we soon reached and forded; its course here N.W. On the opposite bank, fell in with frequent herds of wild cattle, that stared at us in seeming defiance. V.'s horse knocking up, he was imprudent enough to bathe him in the river, and brought on the staggers; from which the contents of my flask with difficulty recovered him. His servant was obliged to lead him to Puedpa. Among the bushes, was surprised by the sight of a black tiger-cat crossing close to me. He appeared about two feet high, and full four feet in length. Was assured this animal is rarely met with. Proceeded still over savannahs well watered, and equally stocked with wild cattle. Reached Puedpa not before five P.M., well fagged and my horse a little cut by the saddle. This place is famous for nothing but the richness of its savannahs and number of wild cattle in the neighbourhood. It is a small mission, and in 1803, reckoned but 291 inhabitants. being with Santa Clara, which contained 285 only, the smallest of the whole range. The Indians are chiefly Guayanos, mixed with a few Guayacas. Soil hereabouts very fertile, and capable of high cultivation. The plain of wide extent. We had traversed upwards of 14 leagues. The hills of Cupapuy faintly distinguishable towards the N.N.E. Westward, the level continues to Euri. The date of this mission is 1769. Site agreeable, but Labranza inconsiderable. Found here an excellent shoemaker, who mended our saddles. The manager regaled us with abundance of sweet potatoes, served up with unusual decency. The present aspect of Puedpa is dreary; the Guayacas had all fled, and Santa Clara been nearly abandoned. The population cannot now exceed 150; the fever had penetrated

hither, as well as to Pastora, though not so virulent as elsewhere.

2d. Borrowed fresh horses, our own requiring rest. Rode over to Santa Clara, distant about three leagues, in the hills to the south. Found this Guayaca village beautifully placed on the side of a hill, with a view westward of the woods, and eastward of the boundless plain. Houses all deserted. The residence only inhabited. Parties were out in the bush in quest of the fugitives, but two only had been yet sent in. Saw here little worth notice, except the skin of an *Aboma*, twelve feet long and of considerable breadth. This animal is said to abound here, as also the tiger; we had seen the print of the foot of the latter on our route. It would seem they are here bolder than usual, as the people assured us they would attack a man off his guard. They are reputed to track their prey like the blood-hound, and only to be baulked by taking to the water. The print we had seen was very large and recent. Tried much to procure a specimen of the *Guaco*, the celebrated remedy for the bite of snakes; it is said to be abundant, but my guide would not or could not find one; there is generally a degree of mystery among the Indians regarding medicinal products. Yaparapana or Santa Clara was settled in 1779; the church is still unfinished. Returned to dine at Puedpa, and hearing nothing of U., resolved to proceed for Euri next day.

3d. V. did not accompany us far, either on account of the distance, (sixteen leagues,) or not liking to quit his own district. Traversed plains as usual, and crossing a range of low hills, with a slight detour to the north, entered a succession of other savannahs. Found the waters here take a westerly direction towards the Caroni. A considerable stream we crossed in the middle of the circle must at times be rapid and dangerous. Took the direction straight to Euri. K. and myself trotted on after breakfast; the distance was great and our beasts began to flag, particularly my old *Vaguero*, whose back was now very raw. At four leagues from Euri, espied, at a small distance, a body of seven or eight horsemen, whom we at first judged by their manœuvres to be inclined to intercept us, but were pleased

to find, on coming up, that the party consisted of the mayordomo with his followers catching wild cattle to be mixed with the tame herd. He proceeded with much skill, as follows :— First, driving about twenty tame cattle into a fine pasture, and there leaving them in charge of two or three of his party, who concealed themselves, with the rest he made a circuit, endeavouring to drive in the wild animals by twos and threes, stationing his horsemen so as to intercept their flight; they naturally joined the tame herd, and by being kept constantly together, and driven into the pen at night, soon became domesticated. Twelve had already been thus secured. We met him driving in three, to whom we were glad to give a wide birth. This business requires good horses and experienced riders, both of which are scarce since the late levies. Each man is furnished with a spear, a knife, and a *lazo*, (running noose,) but fire-arms they never carry; so that a traveller provided with them is pretty safe. A league on this side Euri, my horse was completely knocked up. Feared I must have left him in the savannah. He had carried me the whole way from Angostura and well earned his price, twenty dollars. But as I could not afford to lose the saddle, contrived to get him on in a walk, but did not arrive till five P.M. The baggage came in two hours afterwards. Our host treated us to the customary mess of beef and rice, and a little bad rum enabled to enjoy the extraordinary luxury of cold punch. It was absolutely necessary to recruit our beasts, and purchase another baggage-mule, my poor animal being in too shocking a state to hold out longer.

4th. Halted at Euri, or Guri, and enjoyed the luxury of bathing twice in the Caroni. This river runs from the south, but, encountering a large mass of mountains a little below Euri, makes a considerable sweep westward in order to avoid and pass round them; it is navigable hence up to Barceloneta, but below is full of rocks and rapids the whole way to its embouchure; one of them was distinctly audible from the town. About a mile above the town is a ferry, by which there is one way of communication with Angostura. Should have returned by this route, but wished to visit the missions on the Orinoco. Guri

was settled in 1771. Its population in 1803, 792. The fever has been very destructive. In fact, the low grounds near the rivers are of course less healthy than the high levels of the interior. Sickness still prevailed, although the virulence of the disorder had abated. About forty were ill. The Guaycas, who formed the bulk of the settlers, had shewn their usual spirit and retired into the woods; not more than 150 people remained. Counted thirty women who came to receive rations. Rummaging the library, laid hands upon one paper only of any interest. This I immediately copied. It was the return of the state of these missions made to the General of the order in 1803. In the evening the girls assembled, as is customary upon the arrival of strangers, to divert us with a dance. The manager asked if we had seen the Caraib war-dance, and gratified our curiosity by summoning all the boys capable of performing it, to the number of eleven. These were ranged in three files. One took the lead in the character of Montezuma. The dance consisted of four parts, all executed to the sound of the violin. The first represented a review, and the marching and countermarching of troops in exact order before the chief, performing a variety of evolutions. The second, a religious procession with garlands, *&c.*, to propitiate the Deity, and take the oath of fidelity, *&c.*, to the sovereign; after which a message is brought, demanding their submission to the king of Spain. It is received with disdain. The warriors seize their arms and rush to battle, first with bows and arrows, which they twang in regular time, and then with clubs or sticks, with which they attack and defend with great dexterity and variety of attitude. The fourth part represents a pursuit, in which each endeavours to seize Montezuma, whose art consists in avoiding the grasp of the pursuer with a sudden jerk, and giving him a blow on the back. The interlude closes with a scene of true Mexican devotion to the chief. All swear to die rather than submit to the Spaniard, and each is killed in succession by Montezuma, who finally falls by his own hand. The dancers were all Caraibs, and the diversion originated in the inveterate hostility of that tribe to the Spaniards; but the name

C 2

of Montezuma is evidently of Spanish introduction. The message and defiance are both delivered in the ancient Caraib language, and with a spirit, that seemed to exhibit a strong tincture of national animosity even in the breast of these their civilized descendants. The exact time observed throughout the whole of the evolutions was astonishing, more particularly in the club attack and defence, which must have taken very long practice.

Was obliged to procure another baggage-mule. The only one procurable was very wild and wicked. She threw the old *petaca* (shoe-maker,) and John in a twinkling; but there was no alternative, so gave 35 dollars for her, and bespeaking a guide for the morning, retired to rest. Euri has, perhaps, on the whole, the finest position of all the missions, lying at the extremity of an immense plain abounding in cattle of all kinds. In front and on the south side runs the beautiful Caroni, affording water-carriage upwards to Barceloneta. Behind is a mass of mountains running north-eastward, and connected with the range behind Guayana Vieja. The high grounds abound in fertile spots, and the quina grows in profusion. Found a considerable store of it in one of the out-houses. The direct road to Angostura is long, but runs over level ground. The soil produces cotton, tobacco, rice, maize, *&c.*, in plenty; and the fever might soon be eradicated with very moderate care.

5th. Could not set out before nine, our guide's horse having run away during the night; and as the road branched off in many places, did not venture to proceed alone. Found my horse and the baggage-mule very troublesome and difficult to drive along loose,—the horse turned once and gave me a chase of half-a-mile, consequently made less progress this day than usual, but got over much ground in the ordinary jog trot. Our path in a direction E. by N. over the plain, just skirting the line of hills. Passed the ruins of a farm-house, late the site of the *potrero* of Euri. At noon, passed a rivulet running towards the Caroni; its cool and shady banks tempted us to halt for breakfast. Gave the beasts an hour to graze, and resumed our journey. Fortunately, the mule bought of Matamoro had been

recovered and sent after me from Pastora the day before. Hitherto our beasts had all stood the journey well: but about three P.M., our soldier's little mare knocked up, and he was obliged to lead her. We had too far to go to wait for him. About five it began to rain. Inquiring the direction of Cupapuy, K. and myself resolved to leave our Indian with the baggage and gallop forwards. By good fortune there was a little moon, by the aid of which we distinguished the path, though in many places quite overgrown with high grass and rushes. But my horse knew the track and we proceeded with confidence. Though the compass assured us we were in the right path, we sometimes mistrusted it, and it was nine before we arrived at the journey's end. The whole village was asleep, and it was sometime ere we could gain admittance. When housed, had nothing for it but to strip off our wet clothes and lie down upon the benches. Not a drop even of water to be got. The boys did not arrive till near twelve. As to the soldier, he did not appear till next day, when he marched in on foot with his saddle, arms, and baggage on his shoulders, having abandoned his poor mare in the savannah. This is an incident by no means rare with these wretched animals.

6th. Halted at Cupapuy till noon to dry our clothes. The fever had much abated, though many were still dying of debility and starvation, being unable to go abroad in quest of food. Urged the propriety of issuing rations of soup at least to the sick, and explained the facility of making it from the mere bones by length of boiling. Afterwards procured an order to that effect from the commissioner. The total burials at this place, exclusive of the *Labranza*, had been 320. Found here U.'s servant, Jacinto, sick. Learnt from him that his master had set out to join us, but had the next day returned with a smart attack of fever, and was now at Upata. Accordingly, set off at two P.M. to join him. On the way, endeavouring to pass M.'s mule, on which K. was mounted, received a kick that almost broke my leg.

7th. Despatched the soldier on my new purchase to recal Anisette from San Antonio. He returned on foot the day after,

reporting that the boy had gone off for Angostura the preceding day, and that my new mule, although tied according to my directions, had broke loose in the night, and taken the road to Euri, in which direction he had traced her. To add to my misfortunes, the white mule, the only one now fit to carry the baggage, was stolen from the pasture, having been loosed from the horse to which she had been tied. The neighbourhood was scoured in vain. Was now reduced to an awkward predicament. My horse and former baggage-mule were not in a condition to proceed; was obliged to turn them out. No other was to be purchased in the place. Suspicion fell at length upon a man just come up from Guayana for the express purpose of collecting mules. Carried him before the commandant, and though he acknowledged he had taken a mule from my door, and was unable to prove the one he produced (which turned out to have the Government mark, and was forthwith embargoed,) was the same he had taken, yet, as the fact could not be brought directly home to him, contented myself with threatening to shoot him if overtaken upon the road with my mule in his possession. Cannot say what effect this produced, further than that, the day after he left the place, my animal was found in a neighbouring pasture, tied to one of Landa's, which had also been missing. Being still short of cavalry, K. was obliged to purchase a horse of Cornejo, for which he asked thirty dollars, without intending to sell, and was surprised by the bargain being insisted on. Fortunately, also, the tame mule he had bought at Miamo arrived at the same time, and we were once more in a condition to travel.

Staid near a week at Upata, during which Cornejo arrived from Carapo to take charge of the missions, Uscategui having resolved to try the air at Angostura. Took occasion to arrange with the new Commissioner for the transport of the tobacco, which it was agreed should be executed as soon as the corn and provisions had been all forwarded. Also rode over with him to Cupapuy to give instructions for its packing, which was to be done in square bales of hide, weighing three arrabas each, and pressed in the cotton-press. Another day rode over to visit

Matamoro at Santa Maria. Returning, run his own mule against a horse he was on and beat him. Saw there the method of breaking in wild horses previous to bullock-hunting. The *argumentum baculinum* seemed the prevailing one. The poor animal was beaten by two men, one his own rider, and the other mounted on a trained horse, until his spirit was quite broken, and his bones nearly so; no wonder the horses broken-in by the Indians are of so little value. During my stay, had much conversation on the subject of renting the missions. The scheme proposed was, to take four of these establishments as near together as possible, and rent them on the terms of half the nett produce to Government, the other half to the renter; the Indians to be paid for their labour at the rate of 1 rial per day, which, I was assured, was ample, and might be paid half in goods. The cultivation to be of tobacco, of which I calculated upon 1,000 quintals at the least. Cattle to be furnished by Government for rations. Cornejo, who seemed anxious to join in the speculation, strongly recommended his own district, of the population of which he gave me the following statement:

Towns.	Men.	Women.	Children.	Total.
Tumeremo,	36	125	125	286
Tupuquen,	28	60	25	113
Carapo,	40	250	125	415
Miamo,	25	250	130	405
	129	685	405	1,219

According to which, 300 hands might be kept in constant work. Procured from him likewise the following statement of the cattle in his district, and from Velasquez, of those in the southern district, exclusive of the innumerable herds running wild.

Towns.	Horned-cattle.	Mares.	Horses.
Tumeremo,	3,000	300	80
Tupuquen,	4,000	1,200	100
Carapo,	2,000	600	100
Miamo,	1,500	400	80
Cumamo,	100	700	100
Total,	10,600	3,200	460

Towns.	Horned-cattle.	Mares and Horses.
Uasipati,	300	433
Ayma,	550	340
Santa Clara,	99	40
Puedpa,	162	230
Pastora,	1,460	1,100
Total,	2,571	2,143

What a stock for colonization to begin upon! The wild cattle may be reckoned, at least, as many more; and, as far as my information goes, that of the other missions may be estimated as follows:

Towns.	Cattle.
Euri,	300
S. Antonio,	200
Cupapuy,	400
S. Maria,	500
Palmar,	500
Total,	1,900

The remaining missions on the north, under the jurisdiction of the governor of Guayana, have been entirely drained.

Having finished our southern tour, we had now a scene of desolation to traverse on the north. The line of hills in which Upata and Cupapuy are situated, seems to have opposed a powerful, though not insurmountable, barrier to the contagion. Southward of that line, it appeared in a very mitigated degree, and by no means so fatal. Northward, it had nearly annihilated the population. A new stock of rum and bark was laid in, as too much precaution could not be used. Accordingly, we set forward northwards with recruited strength, at the same time that U. took the road to Carnache, which he purposed to reach by short stages in four days, and where we agreed to rejoin him.

14th *Dec.* Left Upata at eight A.M. At Alta Gràcià found our old friend the mayor-domo at length attacked by the fever. Though much reduced, he had not lost his spirits, and seemed to think the pestilence had on the whole abated, though Alta Gràcià presented the same forlorn aspect as before. A drove of mules we had overtaken on the road had so retarded our

baggage, that it was noon before we had breakfasted, and were ready to proceed,—had to encounter them again, in a very awkward place. The savannah continued for about two leagues beyond Alta Gràcià, when we made a circuit round a rugged hill. On the other side, and near the entrance of the forest, found a hut or shed, apparently constructed for the accommodation of the troops on their march to the river. Had by this time approached a lofty range of mountains covered with thick forests, and stretching to an immense distance. Now entered a path that led along a sort of glen or ravine. Wood so thick on either side, as to preclude all view, except where a bare projecting rock or small open space occasionally displayed the romantic dell beneath. Continued ascending for a considerable space, until we found ourselves on the very summit of the ridge, which was on both sides very steep. Halted, as well to rest our beasts, as to seek shelter from a smart shower that overtook us; but did not escape a complete drenching. The road ran through this mountain tract for about seven leagues in length. It was five P.M. before the savannah commenced again. Saw on the road the skeletons of at least 100 horses. These poor animals, if overcome by fatigue in this long woody pass, must inevitably perish; there is not a blade of grass the whole way. In the savannah, came up with a bivouack of Indians employed in conducting a convoy of corn and cassava from Carapo to San Joachim. Learnt from them that we had still four leagues to go, and indeed lengthy leagues we found them. Had another range of lower hills to cross; were benighted in the wood and scarcely able to scramble over the fallen trees. By good luck, however, hit the right road, (it branches off to Caroni,) and at last reached the savannah of San Felix. Never in my life was more delighted to get to a journey's end. It was eight o'clock; we had eaten nothing since breakfast. A young man, who came out to receive us, expressed a doubt of his ability to procure any thing. The *Teniente* and his whole family ill of the fever; the former with a swelled liver that endangered his life; the domestics, three boys, had also the fever, and not five inhabitants remained in this beautiful spot. Got

at length some eatables, tassago and cassava, which, all wet and fatigued as we were, was truly acceptable. Our boys arrived between nine and ten. My horse, and K.'s, were tied together and turned out, as likewise the rest of the beasts with the same precaution. Our wallets being well stored, passed a comfortable night. Slung my hammock in the house. The rest more prudently in the gallery.

15th. In the morning sent for the horses, intending to ride over to San Miguel, and despatch the baggage to Caroni. But K.'s was not forthcoming; suspicion of course fell upon the few Creoles in the place, but without effect. No tidings could be obtained, so left K. and the soldier to search, and gallopped with Jeronymo to San Miguel. San Felix, or Calvary, is a beautiful spot, situated on an elevated savannah, half way between the hills and the river, which is but four miles distant. The woody grounds behind it extremely fertile; in front a savannah covered with tolerable herbage, stretching along the Orinoco from the Caroni, eastward. The view from this mission is magnificent, although the water is shut out by the elevation of the savannah. Judging by the appearance and site it should be healthy, but its vicinity to San Miguel has actually stript it of inhabitants. Its distance from that place about two leagues, and from Caroni three leagues. The road to the former runs across the savannah nearly N.E., but there is a small patch of wood before reaching the town. On the right hand is seen a beautiful amphitheatre of hills, and a tremendous ridge appears to run in the direction of Guayana Vieja. On the left, the Orinoco in all its majesty, just before the division of its waters by the isle of Fajado. San Miguel itself is built upon the sloping side of a hill, looking down upon the Orinoco, of which it commands a fine and extensive view. The town well-built and lately populous; the church in particular roomy and spacious. Its elevated position, and the continual current of the river, ought to ensure its salubrity; but it would seem that, in addition to the annual recurrence of intermittent fevers, which is experienced all along the banks of this river, during the months of September and October, the air had this season ac-

quired a peculiarly malignant character, which can be attributed to nothing but the slaughter of the cattle; and truly the place presented a horrid spectacle. The animals had been killed in the very centre of the square, and the flesh was hung up to dry in the sun on the lee-side, but so thick and near one piece to another, as to aggravate the stench of the offal, *&c.*, *&c.*, left to rot hard by. At the period of my visit, the place was actually beleaguered with horns, skulls, and bones; and though the square itself had recently been swept, and the rubbish burnt, yet the whole environs were covered with the relics, and thousands of vultures gorging in triumph. Even the church had been polluted with the meat; the gallery was still full of rotting hides, which I recommended to be burnt forthwith. The consequences of this criminal negligence were really dreadful; the people employed in the butchery all died; their families caught the infection and perished in the same way. So rapid had the mortality been, that many bodies were to be found in their houses, either altogether unburied, or merely covered by the earth of the floor. The author of so much misery has been most properly displaced: but the present director, who had been endeavouring to purify the town, has suffered severely for the faults of his predecessor. His whole family, himself excepted, is daily attacked by the fever. Five Indian boys are all that remain to do the duty of the place, and these have been brought in from the woods, whither they had betaken themselves. It appears that not a few of the deserters from the late levies which were here embarked, are still lurking in the neighbouring woods, and cannot be induced to return. Breakfasted with the old gentleman upon fish, of which a native employed in the fishery brings him abundance from the river. After remaining an hour to bait the horses, returned to dine at San Felix. K. had been unsuccessful in his search. The baggage was divided into two parcels, the hardened state of our saddles making it impossible for us to carry our valises, and it therefore became necessary to send off one division by water from San Joaquin in order to remount K. on his mule. John had with no small difficulty procured us some eatables, these parts having been en-

tirely stript of their cattle, and depending upon the casual passage of droves from the interior, when embargo is laid upon a beast or two, and they are cut up for tassago.

16th. Left this wretched abode this morning for San Joaquin, reckoned two leagues distant, the soldier driving his loaded mare before him. Road across the savannah in a direction northwesterly. Arrived in an hour and a half. Partook of a part of the tassago shipping for Angostura. After arranging the conveyance of our surplus baggage, walked out to survey the romantic scenery around. San Joaquin is the *embarcadero* of these missions. The reverend padres, anxious to keep every thing out of sight as much as possible, preferred this point to a more commodious one on the Orinoco, a league hence. It stands on the Caroni, immediately below the cataract of the right branch, and in front of that of the left. The river here about half-a-mile broad, and flowing down majestically into the Orinoco. Above, it is most beautifully intersected by innumerable islets, until at length the channel is severed into three branches, precipitating themselves into the gulf beneath. It must be difficult to ascertain the exact difference of level between this and Euri, a distance of above twenty leagues, during the whole of which the river is full of rapids and falls; but the principal fall may be reckoned as about thirty feet perpendicular, which is enough for interest and grandeur of scenery. In crossing the ferry on our outset, about four or five miles higher up, we had distinctly heard the sound: but at that period the rapidity of the current would have considerably impeded our approach. Were much struck with the singular beauty of the spot, and regretted only that it was not in the possession of a man of more taste and industry than its present occupant. The contrast of stinking beef and rotten hides with all this sublimity of nature, was a degrading reflection upon our species. But for the rapidity of the current, San Joaquin would be an admirable station, but being embayed, boats are for want of wind sometimes two days in pulling up. Otherwise, it is well protected by a projecting rock, and is a place of perfect security. Set forward and coasted the river southward, towards Caroni. For

want of any path, it is difficult to ascertain even the exact number of falls. There seem to be three principal ones, but the whole distance may be considered as a continued rapid. Approaching Caroni, the channel expands, and the current appears less violent, and is broken by innumerable rocks and islets, on some of which we could see people fishing. At Caroni it is sufficiently tranquil to admit of a ferry, though much too broad for a horse to swim.

Caroni, the earliest missionary establishment of these parts, was founded in 1722. The church was in 1784 rebuilt of brick, and is a handsome and extensive structure. It stands about two leagues higher up than San Joachin, on a rising ground close to the hilly range, and commands a fine view of the river. The conventual buildings are old and ill-arranged, but, *cosa rara!* have two stories; for, being the residence of the prefect and his subordinate officers, more extensive accommodations were required than at other missions. The Indians well-disposed, and the place reputed healthy; but the fever of San Miguel has desolated it entirely. Not five Indians were to be met with. The creole residents occupied but a single apartment of the mansion, as if afraid of encountering this formidable enemy in solitude; some of them were affected, though not in a dangerous degree. Suspected that a great proportion of the population had taken to the woods. Found in one of the rooms a pile of about a dozen musquets taken from the Creole settlers in the vicinity. It would seem that hereabouts, as well as at Upata, there are many private *conucos.* But if all the Creoles be as poor as one old man who arrived during our stay, they are not much to be envied. My horse had hitherto shown no symptoms of knocking up, but I now found that his hoofs were swelling from the hardness of the rocks, to which he was unaccustomed, and it was requisite to procure another. Saw two; rode one for trial to Murucuri; price demanded, 25 dollars.

Road thither, about three leagues, through woods skirting the river in a direction S.W. Had occasional glimpses of the channel, which was still rocky and full of rapids. Arrived at Murucuri about five P.M. Found the commandant in a dark dismal

hut, in which were mustered about thirty hands, hard at work picking corn. A tremendous pair of stocks stood in our passage, in which it seems the whole were secured of nights, having been lately brought in from the woods. The crop of the season had been most prolific, and the Carnache people had assisted in the harvest, but all had returned with the fever, and some had died. Murucuri, once containing 800 souls, had now not more than fifty, and these had been forcibly brought back from the woods. The site is advantageous, about a quarter of a mile from the Caroni, with the hills behind. The church had been pulled down, probably to make room for one of brick, like those at San Miguel, Caroni, and Carnuache. The inhabitants of the Caraib race; the captain was one of those in confinement. The commandant and his nephew, true Llaneros, entertained us with their campaigns on the Apure, and, like all those I had met with from the Llanos, appeared quite inveterate against the Spaniards. The horse on trial did not give satisfaction, but offered twenty dollars for him, the other not being procurable. Determined to take my chance at Carnache, and slinging in the gallery, while our host slept on his arms in the house, and his nephew Llanero-lita stretched himself on a hide in the rays of the moon. Passed a comfortable night.

17th. Started at day-light for Carnache. Road hilly and stony, running through the woods on the margin of the river. A rude bridge over a torrent very nearly gave way under our weight; K.'s mule struck her leg right through it. Distance about six leagues. Soil in many parts apparently rich, producing excellent high grass. Direction S.W. Entering Carnache from the north, found the pastures excellent. Uscategui had arrived with little Palacio the preceding day. Much fatigued and rather feverish, but proposed to set forward in a couple of days. Agreed to wait, in hopes to recruit our beasts. Accordingly spent the next day at Carnache. John discovered he had left a spoon behind at Caroni, and of his own motion rode back to fetch it. Learnt that the whole of the missions hence on the Caroni and Orinoco, were under the control of the governor of Guayana Vieja, in order to secure the communication with that fortress;

this may be proper as a military arrangement, but the poor inhabitants have suffered by it most severely. On passing our horses over in the afternoon, found mine unable to stir a peg. Was obliged to buy one of the commandant for twenty dollars, who turned out blind, but being young and of good figure did not mind the blemish. U. passed the night on the other side, crossed myself in the morning.

18th. Morales detained the ferry-boat till seven, so were over late. K. and myself resolved to push on the whole way to Angostura, leaving the baggage to make a two days' journey. He mounted on his mule, myself on my new purchase. U. had started before breakfast. Arrived by nine at San Felipe, and were provided with breakfast by the fair tenant. At twelve overtook U. breakfasting in a hut. Halted with him an hour, and at two arrived at Palma Sola, distant from Carnache about nine leagues. It was here absolutely necessary to rest and bait, so entered a hut, where we found an old man and his family, and took possession of two of his hammocks. Our host had been taken as a soldier, but deserted to rejoin a starving family of five children. He had cultivated a provision-ground, which not being yet in bearing, he was obliged to work the alternate weeks for a neighbour who paid him four rials per week. While talking with him, one of his daughters entered with an old matchet which she said the Indians refused to purchase. From the hungry looks of the children, suspected they had been that day without food, so despatched the girl with all the money I had left, a two rial piece, to buy some *cassava*, but alas! it was a new one, and the Indians refused it. Could not help the poor fellow, whose industry and ingenuity interested us; but left a message for our servants, in hope they might pass that way; unhappily they had taken the other. Found the soil rich and good about Palma Sola, and several little *conucos* established there. The Indians of Panapana had their grounds in this neighbourhood, though eight miles distant. At four P.M. resumed our journey. Route through a better country than that of Panapana, though the savannah was very bare of wood. Towards sunset my new purchase began to flag, and could not be

got out of a walk. The mule's pace had knocked him up. Began to calculate on a night in the savannah. The moon had forsaken us before we reached a ravine, across which with extreme difficulty we groped our way; at one place obliged to dismount. The passage took full ten minutes. To my great satisfaction, the animal carried me to Angostura, by a little before eleven o'clock. Had eaten nothing since morning, and at that late hour could procure only a little bread and cheese, and some maize for our beasts. My new purchase promised well; eighteen leagues for the first day's work was no bad beginning; his figure fine and paces good, but he soon after died of a disease in the throat, during the subsequent illness of myself and my boy. Our baggage did not come in till the following evening. The soldier's poor mare so knocked up, that neither force nor persuasion could make her quit the door, where she remained a full week, and then contrived to find her way to the savannah.

Art. II. *Remarks on* Laplace's *latest Computation of the Density and Figure of the Earth.*

It cannot but be highly flattering to any native of this country, to have his suggestions on an astronomical subject admitted and adopted by the Marquis de Laplace: but in applying the theory of compressibility to the internal structure of the earth, it appears that this illustrious mathematician has deviated somewhat too widely from the physical conditions of the problem; partly in order to obtain a convenient and elegant formula for expressing the results, and partly, perhaps, because he was not acquainted with all the experiments, by which these conditions are determined.

Instead of proceeding with the calculation upon the analogy of the well known law of the compression of aëriform fluids, which exhibit an elasticity simply proportional to their density, M. Laplace has at once assumed that the elasticity of a solid body is proportional to the square of the density. Now there seems to be no very good reason why we should suppose the elasticity to increase more rapidly, with the density, in the case of solids or liquids than in that of elastic fluids; and it would be very dif-

ficult to demonstrate that it does not even increase less rapidly. As far, however, as any conjecture can be formed from the loose analogy of the elasticity of steam, compared with that of water and ice, the elasticity of a solid might, perhaps, be expected to vary in the sesquiplicate ratio of the density, but certainly not in the duplicate.

However this may be, M. Laplace's hypothesis is not correctly applicable to the internal structure of the earth; since it either makes the mean density too small in comparison with that of the surface, or the compressibility at the surface too great; and if this hypothesis actually represented the law of nature, it would follow that the earth is not "chemically homogeneous," but that the specific gravity of the internal parts is naturally greater than that of the external. In this respect the simple analogy of elastic fluids will afford us a result more conformable to observation.

M. Laplace supposes the mean density of the earth to be $5\frac{1}{2}$, according to Mr. Cavendish's experiments, and the superficial density $2\frac{1}{4}$ only. Now there is absolutely no rock, either primitive or secondary, of which the specific gravity is less than about $2\frac{1}{2}$, and the mean of a great number of rocks gives at least $2\frac{3}{4}$: so that, allowing for a moderate admixture of metallic substances, we can only consider it as certain that the specific gravity must be between $2\frac{1}{2}$ and 3; and taking $2\frac{3}{4}$ for Shehallien, the mean density of the earth, according to Maskelyne's observations, and Hutton's computations, ought to be 4.95. The determination of Cavendish, however, is susceptible of greater accuracy: his result is 5.48, and it will be safest to adopt 5.4, as the most probable mean of the two series of experiments.

The superficial compressibility, assumed by M. Laplace, is much greater than can be admitted, according to the experiments of Chladni on sound, and to those which have been made in this country, as belonging to any solid mineral substance whatever. A column, of the height of one millionth of the earth's axis, is supposed to produce an increase of density amounting to 5.5345 millionths. Now the modulus of elasticity of glass, and of other compact mineral substances, is generally

a column of about ten million feet in height; nor has any solid been observed, except ice, in which it stands so low as five million. But ten million feet is nearly half the length of the earth's axis; so that one millionth of the axis would be two millionths of this modulus; and the pressure of such a column would consequently produce a variation of two millionths in the density of a solid, or at most of 3 or 4 in the most compressible, and in none so much as 5 or $5\frac{1}{2}$. It must therefore be allowed, that this part of the hypothesis is inconsistent with direct observation.

There is the less occasion for encountering any of these difficulties, as we shall find that the theory of compressibility, in its original form, is abundantly capable of representing the most probable results of all the observations, which it is intended to connect. The truth of this assertion will appear from the inspection of a table, which shows the compressibility and ellipticity corresponding to different suppositions respecting the specific gravity of the earth's surface, taking 5.4, as sufficiently demonstrated, for the mean density.

Mean density 5.4. Elasticity as the density.				
Superficial Density.	**Modulus in parts of the semi-axis.**	**Modulus in thousands of feet.**	**Central density.**	**Ellipticity.**
3.13	.5275	11.024	13.35	$\frac{1}{285}$
3.02	.5048	10 550	14.54	$\frac{1}{294}$
2.79	.4699	9 820	15.78	$\frac{1}{303}$
2.60	.4460	9 321	20.10	$\frac{1}{312}$

From this table we may easily deduce the intermediate results by interpolation: thus, if the ellipticity were found exactly $\frac{1}{306}$, we should have for the superficial density 2.73, or $2\frac{3}{4}$, and for the height of the modulus 9 650 000 feet.

In these calculations, it has not been necessary to have re-

course to any foreign authority or assistance whatever. Dr. Thomson, in his review of the last volume of the *Philosophical Transactions*, has taken the trouble to observe, that Laplace had *before* pursued a similar investigation, although the slightest inspection of the dates of the respective papers might have convinced him, that Laplace had done no more than justice, in acknowledging the true source of the theory in question. The geographical elements of the problem have been supplied by the experiments and observations of Maskelyne and Cavendish, compared with those of General Mudge, Colonel Lambton, and Captain Kater; the computations have been conducted by the assistance of Mr. Ivory's most masterly investigations of the attractions of spheroids, combined with the theory advanced in the *Philosophical Transactions*, together with an auxiliary approximation, for supplying the want of convergence of the series.

It is unnecessary to enter into any inquiry respecting the precession and nutation, as connected with the earth's density, since these effects are known to depend on the ellipticity of the spheroid and of its strata alone, without any regard to the manner in which the density is distributed among them.

London, 2d Jan. 1820. S. B. L.

ART. III. *Geological Description of the Hills which pursue the Course of the Wye, from Ross to Chepstow, with Remarks upon the Characteristics of the Herefordshire Formations, and an Outline of the Stratifications of the Forest of Dean, and the opposite Shores of the Severn. By* JOHN FOSBROOKE, Esq.

[Communicated by the Author.]

THE want of industry and accuracy in acquiring statistical descriptions of the geology of particular districts, has been much the subject of animadversion, among the authors of systems of this science. In matters of general literature, whatever is local can only be interesting to a few, but we should divest ourselves of such particular considerations in relation to subjects of this kind, and reflect that the conformity of the most unin-

teresting district, which can be exposed to our observation, is like a portion of a dissected map, necessary to be gathered up, and adapted to the whole for the completion of the geographical system. By a proper division of circumscribed spaces, each being allotted to the attention of a single qualified individual, who should confine himself to that solely, the geology of our isles would be improved beyond all moderate speculation, and less imperfect data furnished for comparative reasoning and permanent conclusions: still further extended we should have materials for a consistent theory of the earth. With the former view during the summer of 1819, I devoted much attention to the stratified arrangements of certain hills, principally side by side folding over each other, through the gorges of which the Wye flows towards the sea; and I must repeat that if the collocation of these strata should be found uninteresting in detail or common in occurrence, yet viewed as forming a necessary fragment for the construction of an authentic system, a conviction will be obtained that their tameness should not preclude them from regular description. These hills have seldom been viewed but as the parts, which in union compose scenes of picturesque beauty, as the site of architectural antiquities and as the ornaments to the gentle banks and irriguous course of the Wye. The first of these hills near the town of Ross, to the S.E, commences the chain, which forms the septum between the counties of Hereford and Monmouth, and the forest division of Gloucestershire; continuing on, they pass the barrier line of Herefordshire, and commence in Monmouth with Symonds Gate Hill and the New Weir, scenes of extraordinary picturesque loveliness, and are continued to the junction of the Severn and the Wye, at their disgorgement into the Bristol Channel at Chepstow. The provincial names of the principal of these hills are, the Pen-y-ard, the Coppace Hill, Symond's Gate Rocks, New Weir, Great Doward, the Kymin at Monmouth, the Tintern Hills, and Windcliff from Monmouth to Chepstow. Their geology will include a pretty correct statement of that of all the minor hills on the general surface of Monmouthshire and Herefordshire, and the low ground will likewise be included. When I remark that

this account is the fruit of some months' residence, and exclusive and reiterated observation made on the spot, with endurance of much fatigue from pure desire to promote the science, to which I have briefly, but I hope not without improvement applied myself, the accuracy will not probably be suspected. I can only wish it had fallen to the task of some one better qualified; but though a pupil of Dr. Clarke, and one or two other experienced geologists have visited and resided in these districts, I do not know that they have ever given any description in print.

I shall first mention the stratifications in series, and afterwards supply such observations and explanations as are requisite. Geologists differ so much in the use of the various names for the same thing, that I can only promise to appropriate terms which appear to me most divested of singularity. I commence from the lower formations upwards.

1st. Sandstone red and green in ponderous masses, every way intersected by vast fissures.

2nd. An independent and subordinate formation, occasionally encountered in excavating sandstone quarries at the base of mountains. It is very partial in quantity, and irregular in order of position; I conceive it to be formed by a tupha-like infiltration of calcareous matter through the sandstone. It is less compact than limestone in general, the fracture, what is called conchoidal.

3rd. The sandstone grit, or that union of quartz with coarse sand, which is called brecchia, or pudding-stone.

4th. New sandstone, a more delicate fawn-coloured stone than the red sandstone.

5th. Over this, and subordinate even to the sandstones and limestones, we find what are improperly called marls; from the analyses which I have made, they appear to be argillaceous earths with iron and sand.

6th. Mountain limestone.

7th. Shaly limestone, called by diggers the cropstone, forming the cleavage.

8th. Coal. Thin plates or veins dip under the limestone superincumbent upon sandstone, and crop out in slight lines upon the superficial strata as we follow the dip.

The sandstone is one of the most useful of all rocks, its resistance to the wear of centuries, and to the dislocating agency of tempests, is very visible in the durability of ancient fabrics, and its perpetual integrity in mountains. Several castles on the Wye, especially Goodrich, and the romantic abbey-ruin of Tintern, have been composed of this stone. The particular variety of it, which is most used in modern buildings, is the flagstone. With this too and the rough graniform pudding-stone, the most analogous to granite, they form their cider mills, a species of circular trough, in which the apples are compressed, by what, to convey ideas of resemblance, may be called a stone wheel. Iron enters very largely into its composition, and communicates that rusty hue, which, though it is sombre, and free from obtrusive glare, can hardly be deemed beautiful, and is inconsistent with the principles of modern taste, unless ameliorated with artificial plaistering. A considerable portion changes its hue to green, but the red-coloured is predominant. The green is not a distinct colour of a distinct rock, the same stone may have both imparted. I am induced to think that this tinct is resulting from a chemical change: I have observed where water has long remained on the surface of sandstone, and where light and air have gained access, that a green, of the chloritic cast, has appeared in circular discolorations; it is probable then, that some interchanges of action between oxygen and some other united substance, perhaps sulphur, may have given origin to this appearance*. We are to consider, however, as more strictly geological, disposals which nature seems to have made of it. In mountains it is arranged to their lowest depths, in immense cubic masses, every way intersected by fissures, but as regularly disposed as the dry walls of Cyclopian architecture. In the vale its position is infinitely more irregular, scattered in flat masses, and unconformable, giving irregularity to the surface, and covered by a soil so homogeneous, as to display to the weakest perceptions, its alluvial origin. This soil is always abounding in richness and fertility, and though its absorption of moisture is speedy, its retention is lasting. It is what

* I am informed by a very intelligent character, that the green sandstone stands longest in building.

agriculturists term a light *frith.* I include these bucolical observations, because I think that such information is connecting some beneficial objects with geological research, and freeing it from the mere barren pedantry of an unintelligible collection of names, and unprofitable particulars. Whenever a road has been hollowed out, every bank has a lamellar succession of sandstone, gradually crumbling into soil, and hardly retaining its saxified character; thus we trace in the decay of rocks, the formation of plains, not exceeded by any in fecundity and luxuriance of vegetation. This sandstone no where, as I have found, contains organic remains. When I was leaving Herefordshire, I did indeed hear that some way up in the country, a bed of shells had been discovered, but I had no opportunity of making any investigation. It has been said that sandstone never contains fossil shells, but this observation is certainly incorrect.

We must now proceed to the millstone grit. The term brecchia has been given to this; but if I rightly comprehend that term, it is improperly given to a congeries of coarse grit, pebble, and quartz; an original formation. If not formed at the same time, this rock must have early succeeded the sandstone; it fills the channel of the river with its separated pebbles of white quartz, coarse red, and some other varieties. It will give some idea of the united thickness and elevation of the consolidated masses of sandstone below, and the grit above, when I observe that the superior point of every hill, rising at the mean at about an angle of thirty, is capped with the latter of these, and declining suddenly and almost uniformly from N.W. to S.E. the limestone and coal is superimposed, commencing at different degrees of distance from the *summum jugum.* The most singular points of observation which refer to this conglomerate rock is its state of ruin, and disintegration, every where in immense ledges, and here and there rolled into the valleys, and covering the more gradual slopes; it presents however full vestiges of its primordial regularity in its ledgelike cincture of these hills, jutting out at the highest projection, and like dotted lines, marking its dip through their oblong sides to the S.W., and under the limestones. Masses are seen resting against cottages, others descending into the river course, and the plains. We see it in very fantas-

tic forms, especially cubic, and columnar. But in this respect it is imitated by aged bodies of dun limestone, which at the New Weir, form huge wall-like *parietes* to the hills, and more particularly so at Windcliff, and in other situations, like the lonely fragments of immense structures, or as druidical ruins covered with lichens and infant oak-shrubs. It can hardly, be supposed that the flow of springs has formed fissures and burst these rocks. They appear to have been exposed, disunited and precipitated by the operation of torrents washing away the soils on their sides. Enough are left in parallelism to evince their primitive position; we find them increasing in abundance and disunion, lying over the level surface of the hills, above the valley of Troy-mitchell, towards Chepstow. On the common of Trelech, from accidental circumstances of arrangement, they lie over upright stones, like funereal monuments, or cromlechs, and on this spot rather *à propos*, for the great contest of Harold with the Welch ensued here. The pebble which mingles principally with this aggregate rock is white quartz, which gives light on attrition; I have found one or two varieties with difficulty to be discriminated from Carnelian, being very translucent: very pure red quartz also occurs, and has doubtless been scattered from the *debris* of these rocks about the general surface of the lower soil and the bed of the river.

We next come to the new sandstone. Of the quality of this rock I know very little: it is a finer combination of sandy particles than the old, much lighter in colour, and more seldom found. It has been tried in building with expectations which are very far from being verified, probably from its being mingled with calcareous matter.

Above this we find more particularly the marls, red and green. This name is uniformly given and very improperly to these thin talcy stratifications. On analysis I find them to be a ferruginous composition of sand and clay, with about eight grains in an hundred of calcareous matter. Some have supposed them to have been formerly sandstone, and an old rock at Newnham on the banks of the Severn, almost entirely consisting of it, has been conjectured, particularly to have undergone such transition; but it is to be remarked that I have found

it indiscriminately in abundant alternacies, between sandstones and limestones, and streaking through the superficial soils, particularly observable in the sides of the road from Gloucester to Ross. Their two colours are particularly in coincidence with sandstone, and probably the more talcy contains magnesia.

The blue limestone, by some distinguished by the appellation of mountain limestone, is very abundant. On examination I find it a congeries of the cardia genius of shells; above is usually found the brown, similarly composed. Above all, the cropstone a thin, shaly bordering of stone, never used in burning, and very largely compounded with clay. I observe the shells in the brown limestone, here and there crystallizing in circular figures like filligree work. On what this conversion, at all events partial, may depend, I do not know how to explain. A white limestone, is found in masses at the foot of Coldwell and Symond's Gate, and at the top of those hills they are burning one variety, and at the foot another. Under the cropstone of these hills, I found, together with H. Neele, Esq., a friend of no ordinary literary merit, a very shallow but peculiar rock, very compact, but yet in some degree porous, red and marked with shells. At first I conceived it to be trap, but on comminution, and exposure to muriatic acid, I found much carbonate of lime; but the quantity of sand also induces me to believe that some transition between sand and limestone had ensued. I have found specimens of mixed limestone and sandstone like scoriæ. At Coldwell, a kind of dove-coloured marble has been found which will receive a polish, but much too slight in bulk for general use. This country abounds with limestones: the magnesian must occur, but I have not found a very well defined specimen; a strange prejudice has gone forth against it in mixing with soils: the truth is, that in some it binds so firmly as to be too stiff and tenacious for the purposes of agriculture; but a gentleman of considerable mineralogical talents, told me that when in some part of South Wales, he expressed his curiosity at seeing it spread on the soil, and was told that it was indispensable in good cultivation. In burning limestone, that which is most

dense, is generally preferred, though it requires more protracted calcination. The same weight of both denser and looser limestones furnish, (as is, I believe, exhibited by the admirable Bishop Watson's experiments), the same quantity of lime, or very nearly. These are the results of my analysis :—

The blue, or mountain limestone, 100 grains.

	Grs.
Of carbonic acid, ...	40
Lime and a few grains of coloured earthy matter, ...	60

Brown limestone, 100 grains.

Of carbonic acid, ...	44
Lime, *&c.*	56

Looser in its aggregation, and containing more water than the blue.

Limestone is seen in large denuded mountain masses, forming the crown of the hills, and their upper sides at the New Weir; and at Windcliff the Wye flows through a serpentine channel principally formed of it. Smith thus classes the geology of this extremity of the country;

28. Red marl, and flœtz sandstone.
29. Flœtz and magnesian limestone.
30. Red and dun stone alternating.

When we stand on the limited edge of one of these immense and continuous cliffs, one idea must strike the mind, that it could be no other than a mountainous trench to draw off those immense waters which framed a great portion of the formations which I have wandered over, here entering and here retiring. The general elevation diminishes from Ross to Chepstow, so precipitously that it has been stated by some, that the mensuration of Symond's Yate is 2,000* yards above the level of the sea; but this is obviously incorrect. My opinions are, that the low-ground of the Wye has been an entire swamp; that the

* According to Col. Mudge, the height of the Malverns does not exceed 1,444 feet.

dejection of sandstone and brecchia rocks has formed the *terra firma* of the vales. The N.W. acclivity and S.W. decline; the exact correspondence of strata in opposite hills at parallel heights; the springs constantly found *towards the S.W. sides;* the tributary brooks in the gorges of the hills, washing, in their course, sand into the river; the soil being every where alluvial; the line of bearing from Ross to Chepstow; the rocks of pudding stone lying in the bed of the Wye; convince me that the face of the country is owing to these causes, and that the Wye has been formed with a regular channel by a general excavation of the hills in its course. Extensive paludal traces are yet abounding. As to the limestones, I have nothing to offer concerning their origin, I cannot deem them to be synchronous with sandstone, for we do not find them diffused over the alluvial soil, and therefore cannot have been exposed to that operation, to which we are indebted for the latter.

This part of the empire is the great district of limestone ranges. A great part of the solid globe is formed by the union of carbonic acid with lime in both a fluid and a solid state: in fact, in all shapes. It is possible that the base is in a most prolific degree the result of an animal origin, and the gaseous adduct is equally prolific, in combination with the atmosphere. On exposure to a great heat, the black marble of Milford, in Wales, gives a strong fetid smell, from which we may perhaps infer, that the colouring principle is a pigment of animal matter. The limestones which I have mentioned are all congeries of shells: from the secretion of an insignificant shellfish arises a large proportion of the solid structure of the earth. A gentleman in India, to prove the fecundity of the animals of shells, put a few snails in a pail containing water and other things necessary to their existence, and he was surprised to find that they very soon filled it.

We now come to coal. Thin outcrops of this are found every where over the limestone; towards the forest of Dean, it abounds in Mundic, burns very slowly, and leaves much yellow sandy and white flaky residua. Its gaseous contents are less than those of the Northern coals. It has been a speculation, fre-

quently started without success, to find coal under sandstone, and many, of very excellent local information, firmly believe that a proper search would be rewarded with success. It has been said to have been found under the old sandstone rock at Newnham.

It remains to make a few observations on the superficial soil. In the low ground it is easy to observe how the solidity of rocks ceases, in being stratified in an increasing scale, as pressure diminishes towards the surface, and disposed in thin incoherent lamellæ. The river pebbles are of the common character, and not resembling those which are scattered over the surface of the superficial soil, and which are the debris of the sandstone grit, and quartz, in mountainous masses upon the hills. The soil then I repeat is merely levigated from sand-rock, and may be described as a very productive, dry, sandy frith. It abounds with red oxyde of iron, and the high chalybeate character of its hue is very visible in the dell-like morasses which border the Wye about the purlieus of the forest of Dean; and to this some have attributed the particular austerity, which is a local quality of the fruit of Hereford and Monmouth. I have been told that the apple which supplies styer cider, loses its flavour when transplanted from a morassy situation*. As we advance towards the sea, the quantity of ochre in the soil increases; and in the brooks beyond Monmouth, the pebbles over which they wimple, all receive a deep yellow stain. The soil, thus compounded, is admirable for encouraging the growth of the most delicate exotic productions, in the common air. A gentleman, who had spent his life in trying experiments of this kind, named to me places where I might observe every shrub and fruit tree flourishing, for which choice climate and situation is requisite.

I here finish all that I have to give in a state of completion; but I hope that this is but a small portion of the chart, which the future must fill up. Beyond that tract which I have ex-

* Bigland mentions the "Styer, of which a kind of cider is made of remarkable strength and flavour, and of a very perceptible chalybeate taste."

plored to the N.E., we arrive at the foot of May-hill, the pharos of the country; and here I am told some additional stratifications abounding with fossils, mark the limits where we cease to recede from the vestiges of organic existence. From the forest borders to the banks of the Severn, we find a continued mine of unexplored geological treasures; crossing that river we tread upon ground abounding in mineral varieties; and I do not scruple to say from personal knowledge, a region which equally with any other in Great Britain, will prove interesting to the mineralogical traveller. Through the kind communications of Henry Shrapnell, Esq., and my invaluable friend Dr. Jenner, and a sight of their specimens, of which many are exceedingly rare, and connected with some important elucidations, I am enabled to give a bare list of the Gloucestershire series.

From below upwards.

1. Old red sandstone
2. Blue lias
3. Oolite
4. Inferior ditto
5. The clay rag-stone
6. Superior oolite.

In another direction towards Bristol from Berkeley.

Transition limestone cut through with the dyke of volcanic trap at Mickleham
Magnesian limestone
Millstone grit
Mountain limestone.

The Mickleham trap in the parish of Berkeley, was first observed by Dr. Jenner. I was very much struck when first shewn a considerable quarry of this basaltic rock, excavated in such a manner as to uncover its magnificent globous structure, in the midst of a wood, seated on the side of a hill. Mr. Shrapnell and myself traced its sides, where the limestone and sandstone were cut off. The length of its sections, or its general extent, I am unable to give from the loss of my notes; it abounds with minerals, contained in *fissures near the surface*,

especially madrepore coral, chlorite, and zeolite. This circumstance strongly impresses in my belief its igneous origin, and elevation by a *vis ab infra*, as well as its external appearance, and form of crystallization. I found in the trap some specimens of agate, and some singular instances of the conversion of trap with coralline perforations into limestone. Some will suspect a fallacy in this, but I am convinced of its possibility by various examples. Of such conversions by a natural process, we have instances in fossils, for we find shells always primarily constituted of calcareous and animal matter, transmuted into the composition of the strata in which they exist.

In the sandstone of the vale of Berkeley we find shells. I have specimens from the formations here of a peculiar rock at Woodford near Berkeley, two varieties of alabaster, pentacrinite, saxified wood, and amygdaloid.

Through these vales of Berkeley and Gloucester, the mighty vassal of the Bristol channel, receiving half its tide, the Severn, carries its waters: and this same river which, by ocular deception at Windcliff, seems to menace Wales on one side, and Gloucestershire on the other, gave rise, at a comparatively recent period, to a deluge of no ordinary local importance. There is a traditional relation of it among the aboriginal inhabitants, who call it the "Great flood." It occurred in 1607, according to an account in the *Gentleman's Magazine* for 1762, and reached the summit of very considerable eminences upon its banks.

At Abston and Wick, near Bristol, Bigland, in his *History of Gloucestershire*, gives us the following fossil collections: coal, belemnites, astroites, serpent stones, duck's bills. Sir Robert Atkins mentions a cavity under ground, having several funnels, all stopped up. At Austcliff, banks of the Severn, Bigland talks of "a considerable quantity of alabaster under and near the cliff, thrown up by the tide. That this cliff formerly extended further is evident. Out of the cliff have been taken the grinding teeth of some animal, supposed to be those of an elephant. They were nearly as large as a man's fist, and their colour, by lying so long in the ground, was black." At Aure,

"pentagonal stones which, immersed in vinegar, appear to have motion." The same author very accurately enumerates, "nautili, ammonoidæ, ostracites, mytili, pennæ marinæ, asteriæ columnares, found in some of the running streams, but rather scarce; with petrified wood and impressions of leaves, particularly in the tophus stone. In some parts of the superior öolite, we find classed, patellæ in great abundance, though rare elsewhere, buccinæ, cylindric trochi, cochleæ very sharp, and some in the original colour. Anomiæ, cumæi of the smaller kind; pectinoides, many in the original colour; mytili; spines of echini and beautiful fragments of the echini mamillaris, with here and there small specimens of madrepores."

Tupha is found very abundant in the valleys of Gloucestershire. A gentleman, who has much of it on his estates, informs me that it is dug in such a soft state, that it may be cut with a knife, and forms the most durable building stone for his cloth-mills. In Madras it is very abundantly formed by the washing, in heavy rains, of calcareous matter into the bottoms. "For its specific lightness and extreme durability, it was frequently used in vaulting ceilings, set between the ribs of the springing arches. The high choir of the cathedral of Gloucester is a fine specimen of the application of it."

In the blue lias, we find "masses of mundic, and mundicised ammonites, gryphites, asteriæ, ostracites, and large bivalves. In some places layers of coal, very thin and of a fine quality, are inserted in the beds of shells; likewise some fragments of the pearly-shelled nautili of the largest size."

Smyth's observations, who wrote the *Lives of the Berkeleys*, are so curious, that I cannot omit them, being a rare specimen of the science of a literary character of that day. "One found certain stones resembling cockles, periwinkles, oysters, and the like, of such curiosity and delight to looke upon and to consider; of which I rather think to bee the gameful sportes of nature, than with Francastorius the grte philosophr of ths age, to hve bn sometime large creatures, engndred in the sea, and by the wtr cast up on ths and like places, and soo to be shell fishes stonified."

Terminating this imperfect sketch, I must express a hope that Mr. Shrapnell, who has pursued the study of our Gloucestershire geology with uncommon ardour, and excellent local opportunities, will do justice to the subject with his pen and his pencil. In the leisure of a rural life, he cannot want time.

Art. IV. *Description of the Silures or Catfishes of the River Ohio. By* C. S. Rafinesque, *Professor of Botany and Natural History in the Transylvania University of Lexington, in Kentucky.*

[Communicated by the Author.]

The ichthyology of the Ohio had never been explored, until I undertook the task in 1818 and 1819. I have ascertained already that about one hundred species of fishes live in that river, nine-tenths of which were undescribed species, and very few are similar to those living in the Atlantic rivers. I have sent to the *Journal d'Hist. Naturelle*, edited by Mr. Blainville at Paris, the description of many new genera detected in the Ohio, and I now intend to describe the species of the genus *silurus*, which I found in it. They amount already to eleven species and six varieties, which I shall divide into three sections, according to the shape of their tails. It must be noticed that I only reckon in the genus *silurŭs*, those species which have two dorsal fins, the second of which is adipose and distinct from the tail; when they have this last fin united with the tail, they form my genus *noturus*. All the silures of the Ohio have eight barbs near the mouth in four unequal pairs, one above, two below, and one lateral.

Sect. 1. *Silures with forked tails.*

1. *Silurus maculatus.* Spotted catfish. Body elongated, whitish, with small unequal brown spots on the sides, lateral barbs black, reaching the pectoral fins, upper jaw longer, eyes elliptic, lateral line straight, raised at the base; spinous ray of the pectoral fins longer and serrated inside, anal fin with 27 rays, tail unequally forked, the upper part longer.

This species is not uncommon, I have seen it at Pittsburgh, and in the Kentucky river, usual length about a foot; it does

not grow to a very large size. It has a flat head and belly, the upper part of the head is rufous olivaceous, the back tinged of the same but paler hue, the sides have often some gilt and bluish shades. All the fins and tail are marginated or tipped with brown; the spinous ray of the pectoral fins is united to the fin by a cancellate membrane. Iris elliptic, white. Barbs white, except the black lateral ones, and the lower lateral which are tipped with black. D. 1 and 7. P. 1 and 5. Abd. 8. C. 20. Var. 1. *Erythroptera.* Fins and tail reddish.

2. *Silurus pallidus.* White cat-fish. Body fusiform, whitish, unspotted; back olivaceous; lateral barbs black, reaching the pectoral fins; lateral line straight; spinous ray of the pectoral fins, long and smooth; anal fin with 25 rays; tail slightly unequal; upper lip longer; eyes elliptic.

Very common: it grows larger than the foregoing: the body is depressed in the fore part, and compressed in the back part; the upper part of the head is olivaceous; the barbs are white, except the lateral ones, which are always the longest; lips thick, and teeth nearly file-shaped, as in the other species. Iris white, elliptic, transversal. Dorsal and pectoral fins yellowish, abdominal ones white, the adipose dorsal fin olive, tipped with brown, anal and caudal pale brown. D. 1 and 6. P. 1. and 7. Abd. 6. c. 24.

Var. 1. *Marginatus.* Tail pale, marginated with black.

Var. 2. *Lateralis.* Sides with two or three large black patches.

Var. 3. *Leucoptera.* Fins whitish.

3. *Silurus Cerulescens.* Blue cat-fish. Body of a bluish lead-colour, whitish beneath; upper-jaw longer, lateral barb shorter than the head, lateral line flexuose, spinous ray of the pectoral fins shorter and smooth, anal fin with 25 rays, tail equally forked, eyes elliptic.

This species reaches to the weight of 250lbs. It is much like the foregoing, but the lateral barbs are only half the size; the tail is bluish, with a pale reddish base, all the fins are bluish, except the pectoral and abdominal, which are white. Rays as in the above; but C. 22.

Var. 1. *Melanurus.* With a blackish tail.

4. *Silurus argentinus.* Silvery cat-fish. Body compressed, entirely of a silvery white, jaws nearly equal, lateral barbs shorter than the head, lateral line straight, spinous ray of the pectoral fins shorter and smooth, anal fin with 25 rays, tail equally forked.

A small species, rather scarce, seen only once in the lower parts of the Ohio. Length six inches, fins brownish, eyes elliptical.

Section II. *Silures with a bilobed tail.*

5. *Silurus nebulosus.* Cloudy cat-fish. Body olivaceous, clouded with irregular brown spots, jaws nearly equal, eyes small and round, lateral barbs brown, half the length of the head, opercule with a membranaceous appendage, all the fins with a soft spinous ray concealed under the membrane ; anal fin with twelve rays, tail decurrent slightly bilobed or notched, lateral line slightly curved beneath.

A large species, commonly three feet long, often weighing 100lbs. and more. Belly white, fins reddish, eyes singular, quite small, black ; iris round, reddish brown, barb white, lips thick, teeth divided in two tabular files. D. 1 and 7. P. 1 and 9. Abd. 1 and 8. A. 1 and 11. C. 20.

6. *Silurus Viscosus.* Clammy cat-fish. Brownish, clammy ; throat white, jaws nearly equal, eyes round, lateral line curved upwards at the base, lateral barbs one third of the length of the head, spinous ray of the dorsal and pectoral fins short and thick, anal fin with fifteen rays, tail black unequally bilobed, upper lobe smaller and white.

Found near Luisville, at the falls, a small species only four to six inches long, entirely covered with a thick clammy substance, which is commonly covered with dirt. The head is long, flat, and with a furrow above ; body often with bluish and grayish shades ; fins brown, anal fin and tail black ; adipose dorsal fin very large ; iris small, round, bluish. D. 1 and 7. P. 1 and 7. Abd. 9. A. 15. C. 22.

Section III. *Silures with an Entire Tail.*

7. *Silurus lividus.* Brown cat-fish. Body of a livid lead brown, throat pale, jaws nearly equal ; barbs nearly equal, the

lateral ones as long as the head, lateral line raised upwards at the base, eyes round, spinous rays short and smooth, anal fin with 25 rays, tail rounded.

A common species, from six inches to two feet long; head slightly olivaceous, throat of a pale rufous colour, the four lower barbs rufous, head convex above with a furrow; iris round, black. D. 1 and 7. P. 1 and 7. Abd. 8. A. 25. C. 24.

Var. 1. *Fuscatus.* With some faint dark brown patches.

8. *Silurus Melas.* Black cat-fish. Body blackish, jaws and barbs unequal, the lateral barbs shorter than the head, lateral line straight, eyes rounded, spinous rays short and smooth, anal fin with twenty rays, tail semi-truncate.

A small species from three to ten inches long, throat and belly hardly pale, iris black slightly elliptical. D. 1 and 6. P. 1 and 7. Abd. 8. An. 20. C. 24.

9. *Silurus cupreus.* Yellow cat-fish. Body of an uniform coppered yellowish colour, upper jaw longer, lateral barb half the length of the head, lateral line straight, eyes elliptic, spinous rays short and smooth, anal fin with fifteen rays, tail rounded.

It is a large species, often weighing 20lbs. and sometimes 100lbs; the fins are thick, the spinous ray of the dorsal is nearly concealed in the fleshy membrane. D. 1 and 7. P. 1 and 17. Abd. 8. A. 15. C. 20.

10. *Silurus Xanthocephalus.* Yellow-head cat-fish. Iron-gray, belly white, head yellow or with large yellow patches, upper jaw longer, lateral barbs shorter than the head, eyes rounded, lateral line straight, spinous rays smooth, anal fin with 22 rays, tail truncate.

Found in the Ohio, Kentucky, and Licking rivers. Length one to two feet, barb long, nearly equal,—the yellow of the head covers sometimes only half of it, and at other times it extends over part of the body. Iris white, fins thick, reddish, the spinous ray of the pectoral fins as long as the fin, that of the dorsal fin shorter. D. 1 and 6. P. 1 and 7. Abd. 8. An. 22. C. 24.

11. *Silurus limosus.* Mud cat-fish. Brownish, variegated with black, lower jaw the longest, eyes elliptic, lateral barbs reaching to the pectoral fins, their spinous ray shorter and ser-

rated anteriorly, no visible lateral line, anal fin with 15 rays, tail elliptic.

A small species which lives in muddy bottoms, and is always covered with mud. General tinge a rufous brown, belly gray, barbs black, spinous dorsal ray short, smooth, half-concealed in the membrane: spinous ray of the pectoral fins large, broad, flat, and serrated outside. D. 1 and 6. P. 1 and 9. Abd. 8. A. 15. C. 20.

All the silures of the Ohio are probably common to its tributary streams, and even to the Missouri and Mississippi. They are voracious fishes, which live on smaller fishes; they are easily caught with the hook, and are very good to eat, particularly the large species.

There are yet many species in the western rivers of the United States; they may be easily distinguished by attending carefully to the colours, length of the jaws and barbs, shape of the tail, eyes and lateral line, number of rays, *&c.*, which all afford good specific distinctions.

Transylvania University, 1st *October*, 1819. — C. R. RAFINESQUE.

Art. V. *On Fluidity; and an Hypothesis concerning the Structure of the Earth.*

It has been affirmed by *Lavoisier* *, that, without atmospheric pressure, there would be no permanent liquid; and bodies would be seen in the liquid state, only at the very instant of melting, for they would pass instantaneously from the state of solid aggregation to that of aëriform elasticity. Without atmospheric pressure too, there would be no proper aëriform fluids; because, the moment the force of attraction is overcome by the repulsive power of caloric, the particles of bodies would separate themselves indefinitely; having nothing to limit their expansion; unless their own gravity might collect them together, so as to form an atmosphere.

* *Elements of Chemistry.*

In the restriction thus subjoined to his general position, *Lavoisier* has adverted to the mediate operation of gravity in maintaining the liquid state of bodies; but he seems to have all along overlooked the direct effect of the same power in the maintenance of that condition of bodies.

The difference of the three states of aggregation, solid, liquid, and aëriform; (for instance, ice, water, and steam), consists in the circumstance of reciprocal attraction of component particles counteracting their external gravity, as well as their own mutual repulsion, in the one case; and being overcome by those concurrent forces (gravity and repulsion), though neither separately surpass it, in the second; while, in the third, repulsion overpowers the mutual attraction of the particles, though it yet does not likewise prevail over their gravity.

The opposite conditions of a substance are the solid and the gaseous; determined by mutual attraction and by mutual repulsion of the particles. The mean state is that of transition; when the two forces are exactly balanced. It is invariable as independent of external gravity and of its local variations. But there is likewise an intermediate condition, which is that of a viscous liquid, where gravity assists to overcome tenacity.

A viscous or cohesive liquid differs from a non-viscid fluid, as the mutual attraction of the particles is not counterbalanced by their repulsion, though it is overcome by the further aid of external gravity. The particles continue to cohere; loosely, however, so as their relative place in the assemblage or aggregate are subject to be readily changed by an extraneous cause, by gravity or by pressure. Their cohesion and consequent maintenance of position are overbalanced by a repulsive force and by gravity; which, taken together, surpass the adhesive force, though neither of them equal it separately. A solid, whether viscous or brittle, is not alterable in respect of the relative position of its component or integrative particles, by the same causes unaided or unaugmented. Since their external gravity, even acting in the same direction with the repulsive energy, does not equal the cohesive force. A solid aggregate, then, being upheld by extraneous matter, remains unchanged in position in all its parts: a viscid liquid, upon a like support,

is forced by the excess of gravity above the difference between repulsion and cohesive attraction, to take a level form.

Compression, meaning uniform pressure upon all sides of a cohesive aggregate, tends to the maintenance of the relative position of particles. But unequal or partial pressure has the contrary effect; and may serve like external gravity to complete the counterpoise of cohesive and divellent forces, or to give predominance to the one.

A viscous liquid partakes more of the solid than of the fluid state. It is a softened solid, yielding to the gravity of its own particles, and liable to disruption when that power overcomes their tenacity; which consists in the excess of mutual attraction above repulsion. It ceases to be viscid, whenever the repulsive energy equals the attractive.

A non-viscid liquid partakes as much of the fluid as of the solid state. In it, the intrinsic attractive and repulsive forces are exactly balanced: whence the perfect mobility of its particles. It yields to gravity without defalcation from this power: and is held together only by external means opposed to the diffusion of the mass. It is a mean between solid and fluid conditions; and is that point which *Lavoisier* contemplated as the true liquid state.

He considered likewise as a liquid form, that of a compressed gaseous fluid, where gravity mediately assists to overcome elasticity or excess of repulsion above attraction in the fluid. This, however, is no liquid, but gas restrained by pressure. It needs no increase of repulsion, but merely removal or diminution of pressure, or of gravitation not its own, to manifest an elasticity opposed to its gravity. To convert it into a liquid, the excess of repulsive energy must be abstracted.

According to this view, atmospheric pressure, or the gravitation of superincumbent matter, whatever effect it has in restraining an aëriform fluid, has no concern in maintaining the liquid form; which is due entirely to a direct operation, and not at all to indirect influence or mediate operation of causes, whether extrinsic or intrinsic.

Extrinsic causes are here spoken of with reference to repulsion as well as to gravity; deeming it not quite easy to con-

ceive attraction and repulsion of the very same particles exerting reciprocal influence at one and the same time.

For this, among other reasons, it is not unsatisfactory to consider heat as a substantial cause of repulsion between particles which are endued with a mutually attractive power.

Exhibition of heat is attended with dilatation of bodies, as abstraction of it is with contraction. The integrant particles are approximated in one case, and rendered more distant in the other. The cause of increased remoteness is a repellent one; none merely divellent being implied. It may be conceived as a material substance, equally diffused throughout infinite space, or tending to uniform dissemination, whenever that equality is by any cause locally disturbed.

In such a state of equilibrium, a fluid purely repulsive, as heat is here supposed to be, would be an unresisting medium, offering no opposition to the inertness of matter. Equally diffused and perfectly balanced, it presents no resistance to motion nor opposition to rest. For such repulsion, exercised on all sides alike, cannot disturb repose; nor can it impede progression of a body, or of a mass of matter moving consentaneously; since the fluid, alike repulsive in all directions, impels the moving body in accordance with its motion, precisely as much as it conversely opposes it on the other part. But it may resist the coarctation of matter, between portions of which it is interposed: because the approach of matter moving contrariwise cannot take effect, without disturbing the equal diffusion of the repulsive fluid, by pressure of portions which are by that approach displaced.

It is only in maintenance or retrieval of such uniform diffusion, that heat exerts an influence upon the particles of gravitating matter disseminated in it, or between which it is interposed; and affects the position and relative distances of those particles by an energy contrary to their mutual attractive power. By those conflicting forces, a substance is made to pass through all the stages from the solid to the gaseous state.

Heat has been conceived as pushing apart the minute portions of matter, between which it penetrates in seeking its own uniform diffusion; and as insinuating itself for the same end

into interstices by any other cause produced. The permanent elasticity then of a substance, within which heat exercises its repellent power is limited by the attainment of that uniform diffusion.

A certain dose of heat, augmenting a low and overpowered degree of repulsion, until by the aid of gravity it balances mutual attraction, reduces a solid substance to a viscous state, which it retains during subsequent increments of heat, so long as tenacity is not outdone by repulsion singly. A further dose of heat, increasing repulsion till it equals the mutual attraction of the particles, perfects their mobility; and the next addition makes the liquid pass into the elastic form of vapour; and further accession of heat enables it to overcome the pressure of a superincumbent elastic mass, and penetrating it, take a place there suitable to the degree of the elasticity.

The stages of transition from solid to vapour may be brought into one view in a compendious manner, by a notation and expression borrowed from algebraic symbols.

Thus let a represent *attraction* of the particles for each other, r, *repulsion* between them; g, *gravity*, or attraction of the earth's mass. Then $a > r$, denotes *tenacity;* and $a < r$, *elasticity;* and $a \geqq r + g$ signifies the *solid* state of a substance; $a > r$ yet $< r + g$, the tenacious *liquid;* $a = r$, the *perfectly mobile* liquid, and point of transition from the *tenacious* liquid to the *gaseous* state; $a < r$ (but $a + g > r$) the *gaseous* form; $a + g = r$, the *limit* of a terrestrial elastic fluid or gas; and, lastly, $a + g < r$ an *unrestrained elastic* fluid.

In any of these expressions, if one of those quantities vary, another will vary likewise. Thus, if g be taken as variable, as in truth it may, since it differs with the latitude of the place, and elevation of position, then r being constant, a will vary, and the adhesive attraction, which uniform repulsion can overcome, is greater or less, as the gravity of the substance differs. So, making a constant, r will vary; and the quantity of repulsion (or heat, which is the occasion of it,) that is requisite to overpower adhesive attraction, is increased or diminished with the difference of gravity.

It follows that less heat or repulsive energy would be necessary to attain the limit of terrestrial elastic fluidity, while more was required to reach the confines of the solid and tenacious liquid states, at a great elevation, as upon the summit of a lofty mountain, than at the mean of the earth's surface, or (which is not very much lower,) the level of the sea. The difference, however, in requisite quantity, is not very considerable at any accessible elevation. It amounts to but a thousandth part at the height of nearly two miles above the level of the ocean, and two such parts at the height of four.

To pursue this remark, it may be noticed, that the effect of gravity is augmented or diminished by the co-operation or opposition of lunar and solar attraction. For it is obvious, that, if both those forces be acting on the same line and direction with that of the earth's gravity, whether in retaining the particles of a liquid, or in changing their relative positions, a greater power will be required to balance or overcome its effect, than when the same forces are opposed to the gravitation of the earth's mass. The difference, however, is too inconsiderable to be made a subject of observation, as the difference between the concurrence of lunar and solar attraction with terrestrial, and their opposition to it, scarcely amounts to a millionth part.

It is not, however, needless to take that into account, in considering the subject. For, when a gas has reached its limit, if it do so, where repulsion of its particles might precisely equal their mutual attraction, joined with their external gravity, should the power of terrestrial gravity be then counteracted, and its effect diminished, by the contrary attraction of the moon, the elastic fluid might no longer be restrained by the earth's gravitation, but become a free elastic fluid, confined by no terrestrial forces, but only retained in its place by repulsion of contiguous particles of the like ethereal fluid universally diffused.

By gravitation, a particle of vapour, which has barely passed the liquid limit, is restrained from abandoning its position relatively to the earth's mass, and is made to hover at the surface; and by its excess of repulsion above attraction of contiguous particles, it presses, as it is pressed upon, with like or with greater excess of repulsion above attraction.

The relative places of portions of vapour, or of permanent gas, are determined, then, by this reciprocal pressure, as well as by that which gravitation causes. The aggregate, or possible aggregate, must be considered as terminated one way, either by the earth's centre, or, perhaps, by the surface of its solid matter; and the other way, by the variable confines of restrained gas, and unconfined elastic fluid.

Between those extremes must be placed gaseous particles, in all gradations, from that where repulsion barely exceeds attraction, to that in which its excess above particular attraction barely falls short of gravity. The first are lowermost, confined on one side by solid or liquid matter, and compressed on another by the weight of superincumbent gas or vapour. The others are uppermost, upheld by the repulsion of the subjacent gas, and restrained only by the almost evanescent excess of gravitation, above the difference between repulsion and attraction, and by no resistance of repulsive force and gravity of particles situated beyond them.

According to this conception of the aërial sphere, an atmospheric column is an inverted cone, the apex of which reaches the earth's centre; or, considering the column with reference to the earth's solid surface only, it is the frustum of a cone, the summit of which touches the circumference of the earth, and the base reaches the circumference of an orb, the site of equipoise of gravitation and elasticity. Reckoning from the summit of the frustum, and taking it to consist of a given quantity of particles, or atoms, which are nearly in equilibrium of particular attraction and repulsion; every successive stratum, or single layer, consisting of a like number of particles, is deeper, as the compression of gravitating contiguous particles is less; and as gravitation decreases: the mutual attraction of homogeneous particles being lessened with the consequent increase of reciprocal distance.

The density, then, of a gravitating and elastic fluid, the elasticity of which grows with the decrease of gravitation consequent on increase of elevation, is determined by two causes; taking repulsion as constant, *viz.*, direct gravitation, or weight of the fluid; and mediate gravitation, or superincumbent pressure; and, admitting the gravitating tendency of atmospheric air to

be governed by the same law with other matter (that is, inversely, as the squares of the distances,) the densities of the atmospheric strata are in geometric progression, answering to distances in harmonic progression; or, which is the same thing, answering to the reciprocals of an arithmetic progression.

Applying these speculations to the consideration of the structure of the earth, it may be convenient, in the first instance, to imagine a globe having the same mean temperature of its mass, but composed of water exclusively. The density of its liquid superficies may be assumed to be the same with that of the surface of the mundane ocean; and, above that level, an atmosphere of watery vapour, decreasing in density upwards, must be supposed. Below that level the density of the liquid increases with the depth, by the augmented force of gravity acting directly, and also mediately through superincumbent pressure.

Ingenious experiments, yet unpublished, shew that water is more compressible than it has been supposed to be; and the increase of density, as it has been measured under a pressure equal to that of a very long column of water, has been determined at a greater quantity than was to be expected from previous imperfect trials. Without anticipating the publication of those interesting experiments, it is enough for the present purpose to state, that at a certain assignable depth the density of water, and its specific gravity, more than doubled or tripled, would appear to be greater than of those solids, which are known to us as most abundant in the crust of the earth, so far as we are acquainted with it.

It would follow, then, that water, at very great depth, would be capable of floating bodies, which at its surface sink by their superior weight, provided that density and specific gravity increase much less rapidly in the solid than in the liquid, under corresponding degrees of compression.

Let a sphere be now supposed, having the same mean temperature of its mass, and exclusively composed of gas; for instance, atmospheric air. It can be conceived that this gas, more compressible than a liquid, may, in obedience to the power of gravity acting directly, and likewise mediately by superincumbent

pressure, be so distributed in the sphere, as that the density and consequent weight of the compressed gaseous fluid at the centre of the sphere, and to a certain extent around, will be greater than of the liquid, in a like position within the globe before-mentioned. It would be capable then of sustaining, in a liquid form, water introduced into it.

Let those suppositions be combined; and a ball be next imagined, composed of a gaseous fluid, and of a liquid, with solids interspersed. It is easy to conceive the relative compressibility of those substances, and the actual compression of them, to be such, that the interior portion around the centre may be occupied by highly condensed gas; encompassed by a liquid mass, which is pervaded by a gaseous fluid, both decreasing in density upwards; and beyond the liquid surface, surrounded by an atmosphere consisting of gas, penetrated by aqueous vapour.

Solid substances, sparingly scattered in such a fluid ball, would float at a great depth: but the magnitude of cohesive masses, and the abundance of them, may be imagined such that they may be fast locked and fixed together, in the manner of field-ice; at the same time that the weight of them is such, as would float them, were they loose, like an iceberg, with a relatively small portion of the floating mass emergent.

In a word, a solid crust might exist, sustained by the water in which it is immersed, at the same time that the irregular and uneven surface of the cohesive mass emerges in part, while other portions are submerged.

It may be asked, whether the hypothesis here adverted to is opposed by any such conclusive objections, as to be altogether undeserving of consideration? And after remembering that water is permeable to air, and, when exposed to it, absorbs a saturating portion of it; and that air is more compressible than water, and water more so than solids; is it not, in truth, conceivable that the earth's structure may be no other than has been hypothetically put? and might not a theoretical geologist erect, upon some such basis better sustained by correct inductive results, as to the relative compressibility of air, water and commonest solids, a buoyant theory, to account for the seeming intrusion of substances from beneath into superior masses, and

the upheaving of rocks, which apparently once possessed an inferior place: phenomena, for the explanation of which theories yet devised have proved unsatisfactory or insufficient.

I am aware that divers points remain to be discussed, before the hypothesis here hinted could be presented as a plausible one. But it is needless to enter upon the disquisition, and examine and dispose of subsidiary questions, while the main facts are not yet ascertained. It is, then, with a view rather to incite inquiry, than to propose a system, that the thought has been here thrown out.

Experiments upon water, under varied degrees of great compression, are much wanted, with reference to other qualities of the condensed liquid, besides its density, especially its solvent power, its permanent fluidity at an unaltered temperature, however great be its compression, and its capacity of heat. The same may be said of air.

Meantime, it is as allowable to suppose the interior of the earth to be composed of condensed fluids, upholding lighter solids, as to imagine it a compact, impermeable, solid mass, upon which fluids rest. Let well-conducted experiments determine which is the most probable supposition, upon the presumption as a postulate, that the entire mass of the earth consists of substances alike to those with which we are acquainted, being such as its shell, accessible to research, exhibits. H. T. C.

Art. VI. *Extract of a Letter from* Captain William Spencer Webb, 29th *March,* 1819. *Communicated to the Editor by* H. T. Colebrooke, *Esq.*

My last letter was dated from Sírinagar, and immediately after its despatch I accompanied a party of pilgrims to the temple of *Kédár-Nát'h*; one of those shrines, if I may so call it, to which a visit is enjoined by the *Hindu* religion. You have heard so much about mountain-roads, torrents, and precipices, that I need not particularize those which we encountered on this route: suffice it, that we reached the end of our journey without accident of material consequence; and, it being yet early in the season, encountered a good deal of snow near the termination of

our journey, though none remains in the immediate vicinity of the temple later than the beginning of July. The height of the temple above the sea (or rather above Calcutta,) is 11,897 feet, by correspondent barometrical observations, taking a mean between five barometers which were with me, all of them in good order. This is the nearest appulse I have yet made to the base of any very lofty peak. That marked No. 3 in my list* is seen from the temple under so great an angle of elevation as 26° 15′ 15″, and agrees, as well as could be expected, with the position and altitude I had formerly assigned to it. For a history of *Kédár* himself I must refer you to Dr. W.; but even he may not know the legend attached to the temple: and perhaps I shall not excite any profound veneration in your mind when I inform you, that the object, to visit which this pious and toilsome journey is undertaken by pilgrims, is represented by a mishapen mass of black rock, supposed to resemble the *hind-quarters* of a buffalo. *Kédár-Nát'h*, pursued by *Bhím Singh*, was overtaken by that giant near the site of the temple. With admirable presence of mind he transformed himself into a buffalo, and joined a herd of those animals then grazing in the vicinity. The metamorphosis was hardly accomplished when *Bhím* arrived, who, from the probability of the thing, I suppose, suspected the trick which had been passed off upon him, and devised a rare expedient for detecting the object of his pursuit. Placing himself in the attitude of a colossus, he compelled the whole herd to pass singly between his legs. All but poor *Kédár* passed the gauge of trial, but his unwieldy carcase jammed midway. Before *Bhím Singh* could execute signal vengeance on his enemy, the violence of *Kédár's* struggles caused his body to separate into two parts. The head and shoulders diving under ground, safely reached *Népál* by a subterraneous passage, where they may yet be seen. The rump remained a trophy to the giant. Here, as at *Bhadrí Nát'h*, the sins of the flesh may be expiated, and an instant union with the ethereal essence of the Deity be obtained by self-sacrifice. The self-devoted victim is conducted to the gorge of a snowy defile by the *Bráhmens*, among whom he distributes his property and apparel. He is then directed

* *Journal of Science and Arts*, Vol. VI. p. 58.

to proceed in a state of all but nakedness, till he reaches its boundary, a tremendous and perpendicular precipice, whence he is directed to spring into the horrid abyss below. A few days only prior to my arrival, three females of middle age had dared this fearful essay, and strange to relate, returned to the temple alive, after having sought death in vain for three days and three nights, amidst the snow and without food. They did not find the precipice, the existence of which is probably a mere fable*. One of these infatuated women died in a few hours after her return to *Kédár-Nát'h.* The other two had been placed under a shed by the way-side, and asked for charity as I passed. One of them was likely to recover with the loss of both feet and one hand; but the extremities of the other were in such a terrible state of mortification, that a few days must have terminated her misery, enhanced as it was by the conviction, as she told me, that God had rejected her sacrifice and her prayer. Does not your blood chill at this story of woe and wretchedness? Let us hasten on to less painful subjects.

While returning from this pilgrimage, I received the number of the *Quarterly Review* which contains a critique, not very flattering nor encouraging to my labours. The reviewer sweeps aside results which I continue to believe are sufficiently exact, and substitutes for them a series of conclusions deduced from a speculative and, I will venture to add, erroneous theory, combined with facts contained in a narrative of Mr. Moorcroft's *Journey to the Table-Land of Tartary*, or at least to that part of it known to the Hindus by the Hindee name of Oon-des, (Uín-dés,) or the region of *wool*, it being from that neighbourhood that the *Cashmír* market is principally supplied with the material from which shawls are fabricated. I had before deter-

* Religious suicide, by fanatics casting themselves from a lofty precipice, is in like manner perpetrated at a place esteemed by Hindus holy, near *Múl-tápí*, the source of the *Tápí* river, in the centre of India. Being in the vicinity of that place many years ago, I was solicited for alms by a Hindu, who was proceeding to the spot for the purpose of precipitating himself from the devoted rock, in fulfilment of a vow made some years before, as he informed me. I was subsequently assured, that he completed the self-sacrifice in the manner intended; and that instances of such suicides at the same place were not unfrequent. H. T. C.

mined to attempt a journey to Neetee (*Nítí,*) this season, and a desire to meet the reviewer upon the field selected by himself, confirmed my resolution. On my arrival at *Jóshí Mat'h,* which may be considered as the commencement of the defile which forms the road to Tartary, an unexpected obstacle presented. Mr. G. W. Traill, commissioner for the affairs of Kumaon, was proceeding on a mission to the frontier to establish a commercial intercourse with the Tartars ; and you will smile at being told, that the supplies afforded by the district and its population, were too scanty to answer the demands which would have been made upon it had we united our *camps* and proceeded in company ;—though, could you have reconnoitred these same *camps,* you would probably not have been much astonished by the magnificence of our equipments, and still more probably have decided that, bating the number of attendants, the meanest British peasant is more comfortably accommodated. Mr. Traill therefore proceeded alone towards the frontier, leaving me behind in despair of effecting my journey till next rainy season. He reached *Nítí,* the most advanced village in the British possessions, where he experienced a severe attack of illness. The person, whom he had deputed and sent on in advance, represented to him that the Tartar chiefs had declined any personal intercourse with him, and that they had pushed forward piquets of cavalry towards the pass to dispute his advance into Tartary, should he persevere in any such attempt. The bad state of his health, and these untoward circumstances, decided his immediate return to *Jóshí Mat'h,* in the neighbourhood of which latter place, I had been detained by the violence of the periodical rains during this interval. The road was now open for me, though the aspect of affairs was not very encouraging. I was, however, vain enough to fancy, that the little intercourse which I formerly had with the Tartars, had given me some insight into their character. I had no credentials to deliver, no character but *my own* to support, and Mr. Traill, at my request, intrusted to me a small investment of goods destined by Government for the border market, and I set out with the sanguine hope of being able to do more than the event verified. Of the route to *Nítí,* and thence onward to the frontier, you already know

enough from Moorcroft's *Narrative.*—You will observe that in editing that account, Mr. Colebrooke doubts whether the forest trees called cypress and cedar were really observed, and it is probable that he was staggered by the enormous dimensions assigned to the cedar. I found, however, plenty of both, though the cedar is of dwarf size; and there is another species which I conclude to be the creeping cedar. The cypress appears to me to be the *Cupressus horizontalis.* The pines are the *Strobus,* (mistaken by Moorcroft for the *longifolia**, which I did not meet with once); the *Deodar,* (mistaken for the cedar, as no other tree is found of the dimensions quoted by Moorcroft,) and another species, the leaves of which are a good deal like the Yew, but I know not its botanical name. The berry-bearing Yew, is itself of very frequent occurrence.

The exactness of another statement of Mr. Moorcroft's has been questioned. I allude to the difficulty of respiration at a high level; but even considering *my own* sensations as affording no competent evidence, on account of the weak state of my health, I cannot for a moment doubt the existence of this effect, of which the *Bhótéas* are as sensible as strangers; nor are horses or yaks more exempt from its influence than men. It is called by the residents *bis ki huwa,* or poisonous air †. The cause is by them referred to the effluvia or exhalations of certain flowers; and it is supposed to prevail in a greater degree during the early part of the day, and is immediately induced by walking or bodily exertion of any kind. Every person complained of loss of appetite for many days after our arrival at Nítí. For my own part I felt exactly those sensations which precede an

* It is incumbent on me to say, that the error respecting *Pinus longifolia*, as well as that concerning *Pinus Deodar*, (if here likewise any mistake have arisen,) is my own; as Mr. Moorcroft had not furnished those botanical names. My surmise was founded on the knowledge, that both these species of *Pinus* are found in the contiguous but lower mountains of the same range; and the absence of any botanical information at that time, concerning the trees in question, (cypresses and cedars,) which Captain Webb's subsequent visit has now supplied. I presume his cedars are species of *Juniperus*. H. T. C.

† Mr. Fraser likewise encountered this noxious air at great elevations. C.

attack of ague, with great oppression, increased action of the heart, and of the viscera. But one man who was with me suffered one of those attacks to which the *Bhóteas* are subject in the commencement of the season, and which they consider to be more directly produced by the *bis ki huwa.* He had descended to the margin of the river about day-break, and, while re-ascending, lost at once the use of his limbs, and of his recollection; animation was not, indeed, quite suspended, but it appeared to me only a milder fit of apoplexy. His extremities became cold, and after vainly attempting his recovery by frictions, applying hot stones to his palms and feet for several hours, I ventured to give him an emetic, a large quantity of *foam* was thrown up, and in two or three days he recovered.

I staid a few days at Nítí to negotiate for the removal of the outposts of horse before mentioned, and for my own favourable reception on the boundary: all which was easily effected by entering into an engagement not to pass the frontier without a passport.

I had an opportunity formerly of learning the ceremonial with which such engagements are made, and of observing the fidelity with which they are preserved. The form differs but little from the sixpence of lovers "broken in twa," but a stone is substituted, one fragment of which is carried away by each of the contracting parties, and set up in some convenient place as a witness of their covenant.

Proceeding from Nítí towards the boundary I was met, one day's march on our side, by a deputation of respectable persons from the town of *Daba*, and our interview took place on the most friendly terms.

For this, as well as for my general success, I am in a great degree indebted to the accidental arrival at *Daba*, (pending my negotiations) of my old acquaintance the ex-governor of *Tuklakot*, who had been relieved from his office in the usual routine, and was now on his return to *Lassa*, his native place, and also the seat of the vice-regal government of Chinese Tartary.

It should seem that this officer bore strenuous testimony in

my favour; and it is to be hoped that, as he is the *only evidence* to be examined by the Viceroy, he will pursue a similar conduct at *Lassa*. I had purposely talked of my investment, and the profit I had expected to derive from its sale, to every one who visited me, and my surveying concern was quite hidden under the ostensible garb of a trader: in the written communications which passed, I was invariably styled "*Feringhí Béopár*;" or, the Christian Merchant. No objections were made to my proceeding *as far* as the boundary, and though I several times proposed that a horseman should be left with me to see that I did not overstep that limit, I was as often told that it was not necessary, that I had given a promise, and that no apprehension of its due performance was entertained. I was given to understand that my visitors were desirous to inspect the goods I had brought; but I was also told, that no barter or purchase could take place till permission to that effect should be received from *Gurtop*, to whose authority the *Daba* folks are subservient. The bales were accordingly opened, and every thing examined, admired, and admitted to be prodigiously cheap. An old gentleman, to whom I gave a pair of spectacles to assist him in his task, made a most minute schedule of the whole, and of the prices affixed to each article. It was then proposed to me to return, after I should have visited the pass, to Nítí, where an answer was promised on the fifteenth day, and, if it were favourable, the goods required taken off my hands. They were so sanguine in their expectations, that they actually gave commissions for the greater part of the articles to some of the *Bhótéas* who reside at Nítí. The troops set off homewards next morning, leaving me at leisure and alone, to visit the pass, and regale myself, *for the first time*, with a view of the Plateau. Of that I shall speak in conclusion, but must now finish the story of my first mercantile adventure. On the *fifteenth* day, as settled, two Tartar horsemen brought me the reply from *Gurtop*, which stated the impossibility of compliance without authority from the Viceroy at *Lassa*, whose decision is promised when the market opens next year. The despatches were, I know, forwarded out of hand, and the people at Gur-

top *expect* permission to trade at any mart *on our side the frontier.*

This arrangement would answer the purpose, but it seems very possible, that the Viceroy may not feel authorized to consent to such a measure, without previously referring the question to Pekin; and there I fear the event is, to say the least, doubtful.

Among the few " organic remains" which I collected, were some fossil bones : part of these were given to Mr. Ricketts, and a portion to Mr. Colebrooke. The cognoscenti in Calcutta seem to consider them as belonging to the human species; and as I observe that M. Cuvier, in his essay, stoutly denies that any such have been yet discovered, it will be gratifying to the curiosity of geologists, should the fact be so established *.

I have already written such a long letter, and the time I can allot for finishing it is so small, that I must omit the description of the pass into Tartary, with which I purposed concluding this epistle; and limit myself to mentioning, that the crest of the *Ghat*, by a mean of four barometers with me, compared with correspondent observations by Colonel Hardwicke and Mr. A. Colvin, give 16.895 feet for its altitude.

The *observed* angle of depression to the Sutluj River from the same point, is only $1^\circ\ 28'\ 10''$; and consequently the *lowest part* of the valley of the Sutluj River, (the first plateau of Tartary) is about 14.924 feet. The distance to the part of the river, which I observed, is $15\frac{1}{2}$ B. M. by Mr. Moorcroft's map; and as the distance in that map, which I actually travelled over, appeared to me tolerably correct, or at least agreed tolerably well with my measurement, I conclude that there is still less chance of their being erroneous, where the route led over comparatively level ground.

There was not a vestige of snow on the ghat, nor on a shoulder of the hill, which rises some 300 feet above the pass on the left (west) hand. So far from the plateau being buried under perp-

* They are not human; but the remains of animals belonging to some species of deer, or a kindred genus. H. T. C.

tual snow, as the theorists would have it, the banks of the Sutluj river afford pasture for myriads of quadrupeds. The town of *Daba* is tenanted throughout the year; at which place, and at *Dúmpú*, fine crops of *awa* are gathered, a species of grain which the natives consider to be a kind of barley, though Dr. Wallick says, that the sample I sent him, and which is growing freely, appears to be a sort of wheat. The meal it yields is very fine, and the grain being so hardy may perhaps prove an acquisition in some parts of Great Britain. To an *unlearned* observer the *awa*, while in the ear, resembles barley; and when deprived of its husk, wheat.

A mean of the barometrical observations, by Colonel Hardwicke, is taken for the day of my observation, the two days preceding, and the two days following: thus,

COLONEL HARDWICKE.

Aug. 19,	barometer	29.46	thermometer	88
20,	,,	46	,,	84
21,	,,	48	,,	85
22,	,,	48	,,	84
23,	,,	65	,,	81
	Mean	29.51		84.4

Dumdum, 2 P.M.

Mr. Colvin's diary is not complete for these five days, and being observed *at noon*, when the barometer is always higher than at 2 P.M., gives a greater altitude of the pass, *viz.*16, 976.*f.*

Níti Ghát, 3 P.M., mean bar.		16.27 in.	ther. 47°
Differ. altitude	,,	16764	feet.
Dumdum, above sea		+50	or more.
Pass above the sea		16,814*f.*	

Art. VII. *On the Manufacture of British Opium. By the* Rev. G. Swayne.

[Communicated by the Author.]

Sir,

When I sent you the paper on the manufacture of British opium, which appeared in the last Number of the *Journal of*

Science, I had not seen the Essay on that subject in the Second Number of the *Edinburgh Philosophical Journal;* but only a short notice of it in a Bath newspaper. I have since had the pleasure of perusing it wholly. The ingenious author has therein mentioned three different modes of sowing the poppy seed; which being easily referred to, it is unnecessary for me to transcribe.

The method which I have experienced to be the best, is to sow the seed broadcast, from between the fore finger and thumb, in the manner turnip seed is commonly sown, on land *well manured,* dug up with the spade in flat ridges, about half a rod wide; the surface harrowed or raked fine, and the seed, after sowing very *lightly,* raked in. The earlier the seed is sown after the hard frosts are past, the more abundant will be the produce of opium. If it is wished to prolong the time of collecting the juice, so as to employ a smaller number of hands, it will be adviseable to sow the ground intended for this crop at three several times, that the plants may become fit for the scarifying instrument in succession. On this plan, one third part should be sown as early in February *, as the ground can be properly prepared for it; one third more in the beginning of March; and the remaining third part before, or by the beginning of April. I have, indeed, once sown so late as the 20th of that month, and had a moderately productive crop. But sowings so late as this are not to be depended on. Should dry weather of any continuance immediately ensue, they will be worth but little.

When the plants have been up about a week or ten days, or they have three or four leaves each, the ground should be divided into beds three feet wide, with alleys or intervals between, of the width of twenty inches. This may be performed very

---

* Virgil, whose directions in agricultural matters are by no means to be despised, says, respecting the time of sowing poppy seed, Geor. Lib. I. l. 211:

Usque sub extremum brumæ intractabilis imbrem
———————————— cereale papaver,
Tempus humo tegere.

expeditiously by two persons, having each a Dutch hoe or scuffle; and a stick for a measure, three feet long; with two lines fixed on frame-work, twenty inches asunder. This double line is to be strained across three or four ridges at once. The workmen are then to meet midway between the double line, and hoe backwards, which will bring them to the ends of the line at the same time, where they will be ready together to move the line forwards, by laying each his measuring rod on the ground; and thus they are to proceed till the whole is finished. In this way two men can set out good part of an acre in a day. The plants are afterwards to be repeatedly thinned, and kept clean from weeds by the hoe; or, if necessary, by hand, till, at the last hoeing, they are to be left a foot apart, or nearly so. In doing this, care should be taken to leave plants standing as near the *limits* of the beds as possible. Each plant having thus a square superficial foot of soil to grow in, their stalks will become so strong, and they will take so firm root in the ground, that scarcely any wind will have power to blow them down.

I omitted to observe in my former paper on this subject, (which I should have done), that the capsules are to be scarified, and the juice collected *whenever*, and as *long* as they will yield any juice: and the incisions to be made in any part of the capsule where there is a vacancy, *always horizontally*. For if they were to be made in a vertical direction, or any other approaching to that, the attraction of gravitation, together with that of cohesion, would immediately bring all the fluid to the bottom of the incisions, from whence it would as instantaneously fall in single and successive drops on the leaves or the ground, and be lost; whereas, in the horizontal incisions, the juice oozes out in every part of them gradually and equally, remaining collected in globules by the force of cohesion, till the whole of what the capsule will then part with, or at least till sufficient has exuded to make it worth the labour to take it off at once.

I should likewise have directed the collector to repeat the operation with the quill, as often as he observes the juice likely to drop from the capsules after having scraped them, and particularly if the weather is inclined to rain. But if the

weather be settled fair, he may leave what oozes out after the first scraping (provided it be not likely to drop) to be collected early the next morning: when, if it should have proved a dewy night, the capsules will present full employment for his scoop, without the trouble of wounding them. This employment must be attended to as early as five o'clock in the morning, for after the sun has shone on the capsules an hour or two, the juice will be in so viscid a state, that he will not be able to take it up clean.

It is well known to vegetable anatomists, that the milky juice of the poppy, which they term *succus proprius*, and in which alone the narcotic principle resides, is secreted in a tissue of separate cells. In what manner these cells communicate with each other has, not as yet, been determined. But without any doubt they *do* communicate, and that speedily. For an incision, or even a few punctures on any part of the capsule, soon evacuates the juice from the cells, both above and below, and even on the opposite side; insomuch that no effusion will take place in a little while after, by wounding the most distant cells.

Some apology may appear necessary for recommending an instrument with a single blade for wounding the capsules, when so many ingenious instruments, with *two* or more blades, have long since been invented for this purpose. I may be told that in the 16th volume of *Transactions of the Society of Arts*, p. 272, are given a plate and description of a *double* instrument of this kind, called the *nehrea*, which is said to be used by the natives of Hindostan, for making incisions in the poppy-heads That in the 18th volume of the same work, p. 175, two instruments are described, as used by Mr. Jones, one of them with *two* blades, and another with *four*; and that, in the late publication, the *Edinburgh Phislosophical Journal*, Mr. Young has described a double-bladed instrument of *his* invention. Of al these, except the last, I was fully aware, when I adopted the use of a single blade.

It is obvious, that, supposing the edges of the blades to be equally sharp, two blades will require a double force to cause

them to penetrate to an equal depth with a single one, and consequently, will be less easily managed, and with more difficulty be prevented from penetrating *too* deep. But however equally sharp they may be when first used, they will continue so but a very little time. A small difference in the thickness of the blades, in the material of which they are made, or of their temper, will prevent this. They will then require unequal pressure on their several blades, and, therefore, will become still more unmanageable. The inventors of these double instruments have either foreseen this consequence, or have afterwards become sensible of it from experience; and have, therefore, contrived gauges, or guards, to be added to them, to prevent the blades from penetrating further than to a certain depth. Without some contrivance of this kind, it is evident that no double instrument can well be used in the operation in question. And these guards, it is apprehended, can only have their proper effect when used on a plane, or at least a *regularly* bending surface. But it is allowed *, that the capsules of the white poppy are *irregular* and *uneven*; and, consequently, the incisions of the guarded blades, when applied to them, will be unequal in their depth. Add to this, that these double instruments, with their several appendages, cannot but be complicated, unwieldly, and expensive.

Again—The best single blade that I have yet been in possession of, has required, when in full work, to have its edge sharpened once a day. That the necessity of doing this may not, at any time, interrupt the work when circumstances are favourable to it, it is expedient that each person employed in my method of operating, should have the pocket which has been described, as making part of the apparatus, furnished with a spare lancet-blade or two, fit for immediate use, as likewise a spare quill or two. With this provision, the operator may take the advantage of a leisure half-hour, occasioned by a shower of rain, or the intemperance of the sun's heat, or in the evening, to sharpen his instrument. But what is to be done

---

* See *Edinburgh Philosophical Journal*, No. 2, p. 262.

with these complicated instruments their multiplied blades become blunted? To take one of them apart, to set each blade properly on the hone or the oil-stone; and to put it together again, with its several appendages of guards, screws, wedges, bolsters, and mountings, (for which few besides its maker may be qualified) would probably require the best part of half a day.

But further; the flow of juice in the capsules is affected by several circumstances, such as the humidity and temperature of the atmosphere, the moisture and dryness of the soil, *&c.*, so much that, at one time, upon incision, it will flow *freely*, at another time *tardily*, or not at all. The operator, with a single blade, will, on the first stroke, discover how the juice is disposed in this respect, and will, of course, accommodate the number of his incisions to this disposition. If he finds the capsules disposed to bleed *slowly*, he will make but *one* or *two*; if *freely*, he will make *three*, which last number is generally sufficient. But with a double-bladed instrument, he must make either *two* or *four*. Now, it happens, most unfortunately for the offspring of misapplied ingenuity, that *three* is the number most usually required. *Two* do not divide the fluid sufficiently. *Four* divide it too much.

After all, there is no kind of necessity for any double-bladed instrument in this business; since, with a single one, any person, after a very little practice, will be able to make the incisions with all desirable expedition. To scarify *well*, that is, to make the proper *number* of incisions, and of the proper *depth*, is a more requisite acquirement in this work than to scarify *speedily*. It is of much less importance to make the juice flow *rapidly*, than to secure all that *does* flow.

With respect to Mr. Kerr's calculation of sixty pounds of opium per acre being usually obtained in India, (as mentioned in the *Edinburgh Journal*,) Mr. H. T. Colebrooke, in his remarks on the husbandry of Bengal, says *, "We think he must

---

* P. 117. This publication was originally part of an unfinished treatise on the husbandry and commerce of Bengal, the joint production of several gentlemen conversant with different branches of the subject. "which is the reason that the *plural* number is used."

have been misled by the result of trials on very fertile land, in a fortunate season. Such information as we have been able to obtain, has led us to estimate little more than four se'rs, or eight pounds of opium from a bi'gha." Now, as I understand a bi'gha to be about one-third of an acre, this reduces the acreable produce of opium in India from sixty to about twenty-four pounds.

Mr. Young, in his essay in the *Edinburgh Philosophical Journal*, before referred to, tells us, that, in the year 1817, "he collected as much of the milky juice as was *equal* to one drachm of solid opium in the space of an hour;" and that, "in the year 1818, he gathered at the *rate* of two drachms of solid opium in one hour." And he further says, that, "supposing one acre had been cultivated in the same manner (which was by sowing two rows of poppies between alternate rows of potatoes,) as the piece of ground on which his experiment was made in 1818, the produce in that case would have been *equal* to 57℔ 9 oz. and 48 gr. of solid opium." But he no where tells us, that I can perceive, how much milky juice, or how much solid opium he actually collected himself or obtained by the collection of others, from a given quantity of ground.

In the year 1818, I obtained from eight rods of poppies about 52 ounces of *liquid*, from which were made about 30 ounces of *hard* opium, part of which was sent to the Royal Institution. This is after the rate of $37\frac{1}{2}$℔ per acre. In 1819, I personally collected $13\frac{1}{4}$ oz. of *liquid*, from which were made seven ounces of hard opium, from 368 square feet of ground. The calculation from which gives 51 ℔ $12\frac{1}{2}$ oz. to the acre. But the poppies which yielded this unusually abundant produce were of a new variety of *papaver*, obtained in the year 1818, by the process of artificial impregnation, described by T. A. Knight, Esq., in the *Philosophical Transactions*; and at present, as far as I am aware, in the possession of no other person but myself. For, as this new hybrid has flowered but once, induced thereto by a remark of that distinguished physiologist, in his treatise on the apple and pear, expressing a doubt of the *permanency* of such productions, I had intended to submit it to further experiments, that I might be entitled to give it a decided character, before I

allowed it to migrate from the place of its nativity. But considering the circumstances of the times, at the present juncture, to be favourable to the manufacturing British opium, such as the general want of employment among the lower classes in the country, and particularly of women and children, at the season of collecting poppy-juice; the late announcement of new methods of preparation, *&c.*, I was unwilling to lose so much time as would be necessary for such decisive experiments, more especially as my advanced age forbids the expectation of my being able personally to assist in the execution of them. I have therefore adopted what, I have no doubt, will be deemed a much better plan; that of intrusting the greater part of the seed which I have preserved, with the culture and education of its immediate and future progeny, to the guardianship of the London and Caledonian Horticultural Societies; fully satisfied that they will cause the comparative merit of this new poppy, in its intended application, to be properly ascertained.

There are three points of caution particularly to be attended to, in the preparation of opium.

1. The first is, to take care that none (if possible) of the juice be wasted. It must not be suffered to drop on the leaves, or the ground. It must not be rubbed off on the clothes of the collectors. To guard against this last cause of waste, the men and boys should work in sleeve-waistcoats, or jackets without skirts; and the females should have all their garments close and tight about them. But, most effectually to comply with this caution, it is necessary to allot to each person a particular and separate portion of ground, that the operators may not interfere with each other. For this last item of arrangement there is a further reason, *viz.*, that each person's diligence and correctness of operation may be more easily examined.

2. The second point is, to take care that no time be wasted. But in this, indeed, the former is included. If time be wasted, juice will be wasted; for, it is to be recollected, that, from the instant when the capsules begin to yield their juice, they are every moment drawing nearer to that period, when they will yield no more, and that the intermediate space, short in itself, is still

more abbreviated by dry and warm weather. No procrastination must therefore be suffered to purloin any part of it.

3. The third point is, to take care to engage a sufficient number of hands for the quantity of ground occupied by the poppies. From a neglect in this particular, it appears to me that Mr. Jones's failure, mentioned in the essay before referred to (*Edinburgh Journal*, p. 261,) chiefly arose. If indeed he may properly be said to have *failed*, when he received ten guineas per pound for five pounds out of twenty-one pounds seven ounces, and had the remainder to dispose of at the market-price. Mr. Jones, as he himself tells us, had more than five acres of poppies, and only one man and seven or eight boys to attend to the whole, not more than sufficient, according to Mr. Young's calculation, for *half an acre*. But he probably knew pretty well that twenty-one pounds of opium would be sufficient to secure the premium of the Society of Arts, *&c.*; and, being a London druggist, he knew better how to dispose of dried poppy-heads to as great advantage as if he had been at the expense of employing a greater number of hands in wounding and collecting opium from them. It is plain, from what he says in one of his calculations, *viz.**, "Judging from the number of heads we *preserved*," that a portion of the crop *was* appropriated to the purpose of obtaining dried poppy-heads. With which intention, *partly*, it is not improbable that the field might have been originally sown. But, however that may be, it is quite necessary that a sufficient number of hands be engaged, in proportion to the quantity of poppies. In my mode of proceeding, I believe, one person, if skilful and active, might be equal to the management of ten or twelve rods of ground, particularly if it had been sown at different periods, so that the plants might come to maturity in succession. That accurate botanist and correct author, J. Ray, tells us (in his *Historia Plantarum : de Papavere,)* that in the eastern countries the cultivators of poppies are attentive to this point. His words are, "serendo observant, ut unusquisque rusticus *tantum* serat *quantum* putat se habiturum qui colligant." And he

* *Transactions of the Society of Arts.* Vol. 18. p. 170.

says likewise, that he believes, if the inhabitants of Europe were as industrious as those of Asia, opium could be made in this part of the world as well as in that. "Credimus quod si in Europâ ea diligentia adhibeatur quam adhibent, posset etiam fieri sicut in Asia."

When the capsules will bleed no longer, and the seed is nearly ripe, the stalks are to be cut off near the ground with a reap-hook or other sharp instrument, and set up for a few days in stooks to harden. After which* they are to be singly cut off close to the head, thrown into baskets, and carried under cover, to be spread on a floor, or on wattled hurdles set up one above another, or some such contrivance, till they are perfectly dry. When the seed is to be evacuated, by cutting open the capsules transversely, and emptying it out into a tub or other vessel. To all which work, women and children are quite equal.

Before this time, the crop is to be guarded from the birds called Titmice whilst in the field, who would otherwise devour, or rather waste, much of the seed by picking holes at the bottom of the capsules, where instinct tells them they can only come at it; and in the house from the *four-legged* mice, who are quite as fond of this sweet food as their feathered namesakes with *two* legs.

There are two sources of profit arising from a crop of poppies, from which the author of the *Essay* in the *Edinburgh Journal* so often referred to, has omitted to calculate, *viz.*, the stalks, and the dried capsules. The ashes of the stalks when burnt, before they are quite dry, will yield a considerable quantity of saline matter. From less than half a bushel of which I obtained, in the year 1818, four pounds and thirteen ounces, which was found upon analysis at the Royal Institution to be chiefly carbonate and sulphate of potash, but principally the latter. The stalks, when perfectly *dry*, are a good substitute

---

* This direction is applicable only to the *Pap. somnifer. petalis et seminibus albis*, and other species or varieties whose capsules are *closed*. The seeds of all the others which have *open foramina*, are to be shook out when ripe on cloths in the field, in some such manner as that described by the Rev. Mr. Radclift in his *Report of the Agriculture of Flanders*, p. 85.

for small wood in lighting fires, but they are more valuable as affording an excellent material for thatching out-houses, corn-stacks, *&c.*; to which use they are applied, as I understand, in those parts of the Netherlands where they cultivate poppies (Oilettes,) merely for their seed.

From the dried capsules of the eight rods of poppies above-mentioned, after they had yielded as much opium as could be got from them in the manner before described, I obtained, by a particular process*, upwards of three pounds of hard extract, which was afterwards put into the hands of a medical practitioner for a trial of its medicinal properties, who reported that he had found it more efficacious than any extract of this kind he had ever used before.

---

* Considering (for the reasons given in the sequel,) the narcotic substance remaining in them to be in the state of dry opium disengaged from the cells, and chiefly adhering to the external parts of the capsules, and that in this state it was of greater specific gravity than water, I conceived, that in order to obtain this substance in a separate mass, I had only to dissolve and wash it off with hot water; and that, if this was done gently and gradually, it would sink to the bottom of any vessel in which the process might be carried on, in the same manner as the saccharine extract of malt does in the operation of *mashing*. I accordingly had a large mashing-vat filled with poppy-heads, and boiling rain-water sprinkled on them from the rose of a watering-pot, just sufficient (as I supposed,) to moisten and soften the dry opium. In half an hour after, more boiling water was poured on them. They were then allowed to settle for about the same space of time, when the *mash was let run*. The fluid (as I expected,) appeared, both from its colour and taste, to be strongly tinctured with opium. It was permitted to run into the same vessel till the infusion began to be sensibly weaker, when the remainder was drawn off into another vessel, and the poppy-heads again elutriated with boiling rain-water, till it ran off scarcely coloured. The vat was then emptied, and filled again with more dried capsules, and the last running, after being heated to boiling, thrown on them as at first. When the whole had been mashed and treated in this manner, the infusion was evaporated and inspissated in the usual way, and the residuum afterwards formed into hard cakes in the manner of opium. By this process, I apprehend, the narcotic substance is extracted without much of the other ingredients; which last I look upon, in a medicinal view, to be altogether useless. Whether I am correct in this idea must be left to the Faculty to determine.

When the season has been for the most part dry, and particularly the latter part of it, those poppy-heads that have been housed without having been much washed with rain after the last scarifying, will be found to contain more of the narcotic substance, and consequently more valuable to druggists and apothecaries for the purposes of making extract, poppy-sirop, *&c.*, than others which have stood to perfect their seeds without ever having been wounded. This may seem a paradox to them and most other people, that the capsules which have been repeatedly robbed of their narcotic substance, during their growth, should yet at the end of it contain more than others from which none had been taken; but I am convinced that it is a fact, and it may be accounted for in the following manner. The *succus proprius*, or milky juice of the poppy, in which alone (as I before observed,) the narcotic principle resides, continues to ooze out of the incisions in small quantities after the operator has left them, and is, by the action of the sun's heat, converted into hard opium externally on the surface of the capsules, as will be apparent to the eye, but more so internally in the scars and lacerated cells, which juice, not being in its originally fluid state, the seeds have no power of absorbing. Whereas, in the poppy-heads, which have stood to ripen without ever having been wounded, the seeds continue to consume this juice, (for whose use it was, no doubt primarily intended,) as long as any juice is secreted in the cells for their consumption. This circumstance may surely be considered as an additional encouragement to the preparation of opium in this country, where many persons find their account in growing poppy-heads, without making any profit of their most valuable contents.

What the profit may amount to from these two sources which I have particularized, I shall not pretend to calculate; for I should be quite contented (as I think any reasonable person would be,) with the realized balance, as deduced in the *Edinburgh Journal*, from the other products of the poppy; and, therefore, will readily allow the whole amount which may be estimated to arise from both these, to be thrown into the scale with the rest,—to make good weight.

Art. VIII. *On the Variation of the Compass, observed in the late Voyage of Discovery to the North Pole, under* Captain Buchan, *and on the Errors in Longitude, produced by the action of Iron in Ships upon Chronometers. By* George Fisher, Esq.

[Communicated by the Author.]

DURING the voyage the variation of the compass, as may be conceived, was an object of constant attention with the officers of the expedition. The powerful attraction exerted by the iron in the ship on the needle, renders the determination of the variation at sea a problem of the greatest difficulty and uncertainty. The ships were but little time in a high latitude before we were convinced of this; from the great increase of dip, the binnacle compasses were often so sluggish as to refuse to traverse, and, therefore, became useless; recourse was therefore had to those of lighter and better construction.

On the first of June a point of land on the north-west coast of Spitzbergen was seen, and observed to bear S.E. the ship being at the time on the larboard tack, and her head in the direction of E.; but on putting her on the other tack, the same point of land bore S., the ship's head being then in the direction N. by W., making a difference in the bearings observed in each tack of no less than four points, or 45°. Several other compasses were likewise tried, and were affected in a similar manner with those in the binnacle. Jennings' patent Insulating Compass was also tried; this compass, which certainly appears to resist the action of iron *not magnetical,* was, however, not less affected than the others, and continued so throughout the voyage.

Mr. Wales, who accompanied Captain Cook, appears to have been the first to notice the singular effect the position of the ship's head had on the needle; and Captain Flinders, in his Voyage round the World, has afforded us many valuable observations on this subject; his conclusion, however, appears somewhat premature, he observes:—That the error produced by an alteration in the position of the ship's head, varies as the sine of the angle contained between the magnetic meridian and the direction of the ship's head.

The Line of no Deviation, is a term lately applied to observations of this kind, signifying that point of the compass into which, if the ship be placed, the direction of the needle will not be affected by the iron in the ship; that is, if we conceive the whole quantity of iron in the ship to form one magnet, it is that point of the compass in which, if she be placed, the axis of this magnet coincides with the magnetic meridian.

By the rule given by Captain Flinders, it will appear that the error is a minimum when the direction of the ship coincides with the magnetic meridian, therefore the line of no deviation must coincide with the magnetic meridian; if this were the case, and the magnetic dip and force constant, then, indeed, this correction would apply, since that part of the disturbing force which is wholly efficacious, would, by the resolution of forces, be as the sine of the angle contained between the magnetic meridian and the ship's axis. It is natural to conceive that if the iron in a ship were equally distributed, the magnetic axis of the ship would nearly coincide with the ship's axis, or at least be in the same plane. However this may be, it was far from being the case either in the Dorothea or the Trent, particularly in the first, for in no position of her head but W½S., or the opposite point E½N., would the needles in the ship point in the direction of the magnetic meridian; consequently the magnetic axis of the ship made an angle of no less than about 67° with the ship's axis. This was confirmed several times during the voyage, particularly on the 23d and 24th July; the ships were then closely beset many miles with ice, in lat. 80°.17′ N., and from its rapid motion by means of currents they were turned in every direction; this afforded an opportunity of comparing the binnacle compasses with a compass fixed on the main-top-gallant-mast head, judiciously placed there by Captain Buchan, for the purpose of obtaining magnetic bearings, free from the local attraction of the ship. On comparing these compasses, it was found that the only position in which they would agree was when the ship was in the direction W½S, or the opposite point E½N; but when the ship's head was SW½S, by the mast-head compass, the deck compasses where W. by S¼S., being a difference of about 31°.

In the other ship, the Trent, the line of no deviation was about NNE., or SSW.; therefore, the magnetic axis made an angle with the ship's axis of about 45°, traversing the ship from larboard bow to starboard quarter.

In the Dorothea, in which vessel the magnetic axis made an angle of about 67° with the ship's axis, it traversed in an opposite direction from the starboard side *before the beam*, to the larboard side *abaft the beam.*

If now the magnetic axis of the ships, besides their respective inclinations to the axis of the ships, have them inclined upwards, having their south poles nearer the stern of the vessel than their north poles, then can all the observations in both ships be reconciled; since the constant inclination observed during the voyage of the north end of the needle in the binnacle compasses towards the head of the ship can be accounted for, from the proximity of the southern magnetic pole of the ship; and we have the less difficulty in conceiving this to be the case from the curious property iron obtains of becoming magnetical from being insulated in a vertical position, the south pole being constantly uppermost in northern latitudes *.

The difficulty of applying a correction for the error proceeding from local attraction, must be evident when we consider the conditions on which a formula for the purpose must necessarily depend, *viz.*, the magnetic dip and intensity of the magnetic force in different latitudes, conditions which are themselves matters of still greater difficulty.

I shall now give the observations as they were taken, with the circumstances connected with them, that they may afford data in conjunction with others recently made, for any future investigation on a subject so important to navigation.

To the observations of Lieutenants Franklin and Beechey, of the Trent, I am particularly indebted for their skill in taking them, and accuracy in registering every connecting circumstance. I cannot, therefore, do better than insert them, with the remarks made at the time.

* Since writing the above I find I have been anticipated in this idea, by Captain Scoresby, jun., in an excellent paper of his on the same subject.

DATE.	Latitude.	Longitude.	Observed Variation.	Ship's Head.
1818 April 28, P.M.	55°.50′ N	0°.28′ W	18°.40′ W	NbE
30, P.M.	59.13 N	1.22 W	21.14 W	NE
30, P.M.	....	....	24.43 W	NE
30, P.M.	59.24 N	1.15 W	20.17 W	NE
May 10, P.M.	60.40	0.33 W	33.52 W	NE½N
10, P.M.	60.44 N	0.30 W	35.21 W	NE½N
12, A.M.	64.1 N	1.10 E	25.11 W	NEbE
			25.22 W	NE½N
12, P.M.	64.33 N	1.13 E	21.3 W	NEbN
13, A.M.	65.0 N	1.46 E	18.27 W	NEbN
14, A.M.	66.19 N	0.50 E	26.29 W	N½W
	66.25 N	0.49 E	27.45 W	NbW
P.M.	66.41 N	0.50 E	22.35 W	NE½N
			21.11 W	....

REMARKS.
By Walker's Compass.
By Walker's Compass. Ship perfectly steady, taken a stand placed on the companion between the binnacles.
By Kater's Compass. Taken in the starboard-quarter boat. Ship tolerably steady. Card traversed considerably.
Amplitude ⊙ by Walker's Compass. Ship very steady. Taken in the starboard-quarter boat.
By Walker's Compass on the starboard gangway. Observed to differ 8° from both the binnacle compasses being too much easterly, making the variation by them 25°.52 W. By bringing the compass nearer to the binnacle the difference decreased, and upon placing it on the companion between binnacle compasses, it exactly agreed with them; indicating some powerful attraction near to where the observations were made, arising, most probably, from the quantity of iron stowed round the main-mast, consisting of shot, chain-cable, spare rudder with an iron bolt, and the iron fenders. On the forecastle, and just abaft of it, are the spare anchors.
By Walker's Compass on the starboard gangway differed 8° from binnacle compasses, variation by them 27°.21′ W.
By Walker's Compass. Ship very steady.
Ditto Ditto.
By Walker's Compass on the starboard gangway.
⊙ Amplitude by Walker's Compass. Ship steady, agreeing very nearly with the binnacle compasses.
By Walker's Compass. Ship steady.
By Kater's Compass, abaft the rudder head.
By Walker's Compass, agreeing with the binnacle compasses, and taken on the larboard gangway.
Ditto.

DATE.	Latitude.	Longitude.	Observed Variation.	Ship's Head.
1818	° ′	° ′	° ′	
May 14, P.M.	——	——	21.34 W	......
	——	——	21.12 W	......
	——	——	22.47 W	......
	——	——	25.45 W	......
	——	——	24.7 W	......
	——	——	27.11 W	......
15, P.M.	66.47 N	1.18 E	29.56 W	NEbN
	——	——	26.19 W	......
18, A.M.	71.12 N	5.50 E	22.41 W	NEbE
19, P.M.	73.10 N	8.31 E	36.54 W	NE½E
	——	——	39.35 W	......
June 6, P.M.	79.33 N	11.0 E	34.36 W	W
	——	——	30.45	SWbW½W
	——	——	25.59	SWbS
	——	——	37.47	WSW
	——	——	32.43	SW
	——	——	31.42	......
10, P.M.	79.3 N	7.29 E	24.53 W	SbE
			23.13 W	NNE

REMARKS.
By Walker's Compass, agreeing with the binnacle compasses, and taken on the larboard gangway.
Ditto.
Ditto.
By Kater's Compass.
⊙ Amplitude, by Walker's Compass.
⊙ Amplitude, by Kater's Compass.
By Kater's Compass, taken between the starboard gangway and Binnacle. Ship tolerably steady.
Ditto Ditto.
By Walker's Compass. Variation 20°.41′, by binnacle compasses.
By Walker's Compass. Ship unsteady.
Ditto.
By Walker's Compass, on the larboard gangway.
Ditto.
Ditto.
Ditto.
By Kater's Compass, over the companion.
Ditto.
The above six sets of observations were taken in Magdalena Bay, Spitzbergen, where the variation on shore was about 24°.50′ W.
By Walker's Compass. On the larboard tack.
Ditto, On the starboard tack.
In both these observations the ship was steady, and horizon

DATE.	Latitude.	Longitude.	Observed Variation.	Ship's Head.
1818	° ′	° ′	° ′ ″	
June 10, P.M.	——	——	26.40 W	SbE
			24.40 W	NNE
11, A.M.	79.22 N	8.16 E	25.55 W	NE¾E
	——	——	26.42 W	......
11, P.M.	——	——	15.52 W	E8°S
	——	——	17.35	......
13, A.M.	79.50	.45 E	22.26.14W	......
P.M.	——	——	24.29.14W	......
	——	——	25.13.52W	......
	——	——	23.27.0 W	......
	——	——	21.14.0 W	......
20, P.M.	79.57 N	112 E	19.30.30W	......
	——	——	21.55.0 W	......
	——	——	24. 2.0 W	......

REMARKS.

good. The bearings of a point of land were taken before and after tacking, and were found to be the same in each case. The binnacle compasses likewise agreeing.

By Kater's Compass. On the larboard tack.

Ditto. On the starboard tack.

The same circumstances occurred in two observations, as in the former two.

By Kater's Compass.

By Walker's Compass, on the starboard gangway.

The compasses in both cases agreeing with the binnacle compasses.

By Walker's Compass.

By Kater's Compass.

Both sets of observations taken on the starboard gangway. The direction of the ship's head by the azimuth compass was E. 19°. S. Ship steady.

By Walker's Compass. Taken on the ice at a considerable distance from the ship, free from any local attraction.

By Walker's Compass. On the ice as before.

Ditto. Ditto.

By Kater's Compass. Ditto.

By Walker's compass. Ditto.

By Walker's Compass. On the ice.

Ditto.

Ditto.

The mean of these is 21°.49′ W.

DATE.	Latitude.	Longitude.	Observed Variation.	Ship's Head.
1818 June 20, P.M.	° ′ ——	° ′ ——	° ′ ″ 24.3 .30W	......
			24.73.0 W	......
			24.18. W	......
——	——	——	23.42.30W	......
			24.45.0 W	......
			23.49.0 W	......
21, A.M.	79.56 N	11.21 E	23.21 W	......
			23.53 W	......
P.M.	79.56 N	11.32 E	31.9 W	SW
——	——	——	25.28 W	......
			25.8 W	......
			24.8 W	......
22, P.M.	79.57 N	11.15 E	29.19 W	......
——	——	——	24.17 W	......
23, P.M.	79.49 N	10.14 E	23.43 W	SSW½W
24, P.M.	79.38 N	8.51 E	39.41 W	N

REMARKS.

By Kater's Compass, (No. 1.) On the ice.

Ditto.

Ditto.

The mean of these is 24°.19′ W.

By Kater's Compass, (No. 2.) On the ice.

Ditto.

Ditto.

The mean of these is 24°.5′ W.

By Walker's Compass. On the ice.

Ditto.

The mean of these is 23°.37′ W.

By Kater's Compass, (No. 1.) The compass was placed nearly a-midships, at a sufficient distance from the binnacle compasses, to prevent attraction. Weather very fine, and ship immoveable in ice.

By Kater's Compass, (No. 2.) On the ice at the same time with the above.

Ditto.

By Walker's Compass. Ditto.

By Kater's Compass, (No. 1.) The compass was placed on the companion in mid-ships.

By Kater's Compass, (No. 2.) On the ice at the same time.

By Walker's Compass. Taken on the starboard gangway, and agreeing with the binnacle compasses.

By Walker's Compass. On the starboard gangway. Ship's head by the azimuth compass N. 18°. E.; variation by the binnacle compasses 21°.41′ W., being a difference of no less than 18°. from the different situation of the compasses.

DATE.	Latitude.	Longitude.	Observed Variation.	Ship's Head.
1818 June 24, P.M.	° ′ 79.45 N	° ′ 9.20 E	° ′ 14.49 W	SEbE
——	——	——	12.41 W	......
25, P.M.	79.41 N	9.29 E	3.10 W	S37°E
——	——	——	13.21	E11°S
July 2, P.M.	79.48.17 N	11.30 E	24.14 W	......
	——	——	24.7 W	......
10, P.M.	80.21 N	10.38 E	23.33 W	......
	——	——	26.2 W	......
	——	——	26.33 W	......
19, P.M.	80.24 N	11.14 E	24.5 W	......
			23.46 W	......

REMARKS.

By Walker's Compass.

By Kater's Compass, (No. 1.)

In both cases the compasses agreed with the binnacle compass. Previous to tacking this afternoon, a point of land bore EbN.; and when the ship was round, it bore SEbE., making a difference of no less than four points in the direction of the needle, arising from the different position of the ship's head.

By Walker's Compass. Laying too in a very heavy sea. Direction ship's head by azimuth compass S. 75° E.

By Kater's Compass, (No. 2.) Agreeing with the binnacle compasses.

By Kater's Compass. On a rock at Observatory Isle.

Ditto.

By Walker's Compass, taken on the ice.

By Kater's Compass (No. 1.) ditto.

By Kater's Compass (No. 2.) ditto.

After these observations were made, Walker's Compass was removed on board the ship, to observe what difference it would shew there from Kater's Compass left on the ice were the azimuths were taken. Walker's Compass was placed on the companion ship's head at the time E.N.E.

⊙ Azimuth on board,[1]	N. 38°30′ W. —	38°45′ —	38°45′
Ditto on the ice,	N. 28°44′ W. —	28°39′ —	28°29′
Diff. - - - - - - - -	9°46′	10° 6′	10°16′

From these observations it appears, azimuths taken on the ice free from the attraction of the ship, would have given 10° more westerly variation than those taken on board with the ship's head in direction E.N.E.

By Kater's Compass, (No. 1.) On the ice.

Ditto, (No. 2.)

DATE.	Latitude.	Longitude.	Observed Variation.	Ship's Head.
1818 July 21, A.M.	° ' 80.14 N	° ' 13.2 E	° ' " 23.16 W	......
P.M.	80.12 N	13.2 E	24.27 W	......
			24.47 W	......
			25.16 W	......
			24.12 W	......
			22.54 W	......
			23.5 W	......
			23.20 W	......
			23.54 W	......
24, A.M.	80.18 N	12.38 E	22.28 W	......
	——	——	22.8 W	......
	——	——	24.20 W	......
P.M.	80.18	12.38 E	23.56 W	......
	——	——	25.2 W	......
31, P.M.	79.55 N	11.14 E	38.41 W	NWbW
	——	——	37.49 W	NW
August 8, A.M.	79.39.37	11.6 E	24.49.45W	......
12, P.M.	——	——	23.51.30W	......
27, A.M.	——	——	24.19.12W	.....
28, A.M.	——	——	24.57.45W	......
P.M.	——	——	24. 5. 0W	......
12, A.M.	79.40.20,6	11.7.24 E	24. 1. 4W	......

REMARKS.
By Kater's Compass, (No. 4.) On the ice.
By Kater's Compass, (No. 1.) On the ice.
Ditto, (No. 2.) Ditto.
By Walker's Compass. Ditto.
Ditto.
Ditto.
Ditto.
Ditto.
Ditto.
By Walker's Compass. On the ice.
Ditto.
By Kater's, (No. 3.)
By Kater's, (No. 1.) On the ice.
Ditto, (No. 2.)
By Kater's Compass. Binnacle Compasses agreeing.
By Walker's Compass. Ditto.
By Kater's Compass. On S.W. point of Dane's Island.
Ditto.
Ditto.
Ditto.
Ditto.
By Walker's Compass, at the Observatory, Dane's Island.

DATE.	Latitude.	Longitude.	Observed Variation.	Ship's Head.
1818	° ′	° ′	° ′ ″	
August 12, A.M.	——	——	24.13.24W	......
P.M.	——	——	25.12.33W	......
	——	——	24.48.38W	......
30, P.M.	79.41 N	9.40 E	° 5.56 W	N½W
Sept. 8, A.M.	77.21 N	0.57 W	37.24 W	SSW½W
28, P.M.	63.7 N	8.24 W	23.26 W	SbW
29, A.M.	62.32 N	7.54 W	36.58 W	SbE
	——	——	38.15	SbE½E
	62.32 N	7.54 W	36.58 W	SEbE½E
			38.15	......
			39.54	......
			37.11	......
		Mean	38.5	
Oct. 2, A.M.	60.37 N	9.19 W	31.39 W	SW½W
4, A.M.	59.58 N	7.24 W	25.25 W	EbS¾S
5, A.M.	59.17 N	2.24 W	30.30 W	W.b67.°S

REMARKS.

By Walker's Compass, at the Observatory, Dane's Island.

Ditto.

Ditto.

By Walker's Compass, taken on the larboard gangway. Variation by binnacle 20° W.

By Walker's Compass, taken on the larboard gangway. Variation by binnacle 26°.9′ W. Ship had much motion, heavy sea.

By Walker's Compass, taken on the starboard gangway. Variation by Binnacle Compass 20°.37′.

By Walker's Compass, on the larboard gangway. Variation by Binnacle Compass 18°.43′ W.

Ditto, Variation by Binnacle Compass 18°.3′ W.

By Walker's Compass.	Variation by Binnacle - - -	18.44 W. (° ″)
Ditto	Ditto - - - - - - - - - - -	17.23
By Kater's Compass, (No. 2.)	Ditto - - - - - - - - - -	23. 2
Ditto (No. 1.)	Ditto - - - - - - - - - -	20.19
	Mean - - -	19.52 W.

From these observations it appears there was no less than 19° difference between the compasses when placed on the larboard gangway, and the binnacle compasses.—Weather fine and favourable for observation.

☉'s Amplitude by Walker's Compass, taken on the larboard gangway. Variation by binnacle 26°.2′ W.

By Walker's Compass on the starboard gangway. Ship's head by azimuth compass E.S.E.

By Walker's Compass on the larboard gangway. Variation by binnacle compass 23° W.

The great difference perceptible in these observations is very remarkable, arising not only from the different position of the ship's head, but also from the different parts of the vessel in which the azimuths were taken; it was, therefore, always necessary to compare the azimuth compasses at the time of observation, with the compass by which the ship was steered, in order to obtain the proper variation to be allowed on the course steered.

It would likewise be advisable, if it could be done, to have a compass placed in midships, so that the vessel might always be steered by it, which compass should always be considered as the standard compass; and whenever azimuths or amplitudes are taken in any other part of the ship, a comparison should be made between this and the azimuth compasses, by repeating these observations on opposite tacks and courses, an approximate correction would be obtained, and likewise a knowledge of the proper variation to be allowed on the course steered.

Indeed, whenever the weather would permit, a knowledge of the true variation might always be obtained by azimuths taken at the mast-head, independent of the ship's attraction; for the sphere of influence of this attraction appears to me to be exceedingly limited, as plainly appears from the agreement of azimuths taken on the ice close under the ship's sides when they were beset with ice, and those taken on the ice at a considerable distance from the ships. It likewise appeared from the bearing taken with the mast-head compass, agreeing with those taken on the ice. On the 21st July, 1818, at midnight, the sun's azimuth was taken on the ice about eighty yards from the ship, and found to be 27°. W.; and in order to determine the effect of the ship's attraction on the needle, I immediately placed the azimuth compass on the ice, close under the ship's bow, and allowing for the sun's motion in azimuth, it was still 27°. W.; but on removing it on board, and placing it on the ship's gangway, it was then 21°.45′ W.—the ship's head at the time W.bS. Since, therefore, no sensible effect was produced on the needle by a near approach to the ship's side, much less probable is it that any effect should be produced at the mast-head, where the

disturbing force would act nearly perpendicularly to the plane of vibration of the needle.

On the Diurnal Motion of the Needle at Spitzbergen, August, 1818.

The observations here given were made with an excellent variation transit, made for the purpose by Dollond. The transit had a motion in azimuth, by which the telescope of the instrument having a microscopic cap attached to the object glass, might be brought parallel to the needle which was fixed on a centre under the axis of the instrument in a glass cover, by this means the slightest motion in the needle could be observed, and the variation *read off* with considerable accuracy on the azimuth circle. The observations were made on a small island on the north-west coast of Spitzbergen, in lat. 79°.40′.20″,6 N., and long. 11°.7′ E. The transit was firmly fixed on a foundation of solid rock, on a spot where a tent had been previously erected for the purpose. On the 12th of August, having by observation put the instrument into the meridian, the variation was observed, and observations continued at equal intervals of about four hours, both day and night, during our stay on the island. The needle, although of the most delicate construction, was yet so extremely sluggish as often to differ four or five minutes in the *readings* when taken immediately after one another. Each of the following observations is, therefore, a mean between five distinct observations, taken immediately after one another, the needle being put gently in motion between each observation, and its motion accelerated by slightly tapping the glass cover.

The observations were taken alternately by myself and Mr. Charles Palmer, midshipman of the Dorothea, to whom for his skill and accuracy in observations of this kind I was particularly indebted.

Observations on the Daily Change of Variation, Spitzbergen, Lat. 79°.40′.20″,6 *N., Long.* 11°.7′ *E.*

DATE.	Variation.	Thermometer.	Barometer.	Wind.	WEATHER.
1818. Aug. 12, Noon	24°.0′	39°.2′	29.437	Vari^b.le	Fresh breezes & cloudy.
	23.35	35.8	.456	E	Strong breezes ditto.
	26.30	30.3	.494	ENE	Ditto.
Midnt.	26.30	31.2	.516	NE	Ditto.
	26.30	33.1	.518	ditto	More moderate.
	26.30	35.3	.540	ditto	Calm and cloudy.
13, Noon	27.6	36.3	.562	ditto	Ditto with snow.
	27.36	37.6	.550	NNW	Ditto.
	27.26	35.1	.570	W	Moderate and cloudy.
Midnt.	27.34	36.0	.564	SW	Fresh breezes.
	27.7	35.7	.512	ditto	Ditto and cloudy.
	27.10	38.2	.484	ditto	Ditto.
14, Noon	27.21	42.0	.460	ditto	Ditto.
	27.21	43.0	.456	NNE	Moderate breezes and cloudy.
	27.21	40.0	.420	ditto	Light breezes ditto.
15, Midnt.	27.1	39.0	.398	ditto	Ditto.
	27.1	41.5	.398	ditto	Ditto.
	26.54	41.4	.398	ditto	Calm and cloudy.
15, Noon	27.13	43.8	.398	N	Calm and cloudy with rain.
	27.9	41.2	.386	ditto	Ditto.
	27.0	34.2	.386	ditto	Strong breezes with snow.
Midnt.	26.5	33.5	.386	ditto	Ditto, with fog.
	26.26	33.7	.414	NE	Strong breezes.
	27.5	36.0	.454	ditto	More moderate.
16, Noon	27.6	39.8	.480	ditto	Moderate and cloudy.
	27.18	39.5	.509	ditto	Ditto.
	27.1	35.5	.530	HW	Light breezes.
Midnt.	26.48	35.0	.556	ditto	Ditto.

Observations on the Daily Change of the Variation, Spitzbergen.

DATE.	Variation.	Thermometer.	Barometer.	Wind.	WEATHER.
1818.	° ′	° ′			
Aug. 16, Midnt.	26.18	37.4	29.578	W	Light breezes with snow
17, Noon	26.58	36.6	.630	ditto	Ditto.
	26.56	37.2	.658	ditto	Ditto.
	26.52	35.0	.648	ditto	Ditto.
Midnt.	26.21	37.5	.648	ditto	Light breezes, heavy fall of snow.
	26.23	36.7	.632	ditto	Ditto.
	26.37	39.0	.632	SW	Calm, light snow and rain.
	26.24	41.0	.638	ditto	Ditto.
18, Noon	26.26	44.8	.638	ditto	Ditto.
	26.20	39.0	.638	ditto	Ditto.
	26.41	36.7	.648	N	Strong breezes with rain and snow.
Midnt.	26.24	34.9	.646	ditto	Ditto.
	26.25	33.2	.610	ditto	Ditto.
	26.36	37.3	.662	ditto	Strong breezes.
19, Noon	27.4	37.2	.708	NE	Fresh breezes.
	26.59	36.3	.734	ditto	Ditto.
	27.7	35.5	.758	ditto	Ditto.
Midnt.	26.43	34.0	.782	N	Ditto.
	26.32	31.7	.812	ditto	Ditto.
	26.20	37.0	.832	ditto	Moderate and thick weather.
20, Noon	26.43	40.0	.832	ditto	Ditto.
	26.44	40.3	.832	ditto	Light breezes.
	27.12	40.5	.832	ditto	Ditto.
	26.52	35.3	.720	SSW	Ditto.
Midnt.	26.54	36.0	.665	SW	Fresh breezes and squally.
	26.44	35.5	.580	W	Ditto.
	26.58	38.5	.600	SW	Moderate and hazy.
	26.14	38.5	.606	ditto	Light breezes and hazy.
21, Noon	26.56	39.7	.624	ditto	Ditto.

Observations on the Daily Change of the Variation, Spitzbergen.

DATE.	Variation.	Thermometer.	Barometer.	Wind.	WEATHER.
1818. Aug. 21, Noon	27.11	37.0	29.870	E	Fresh breezes and cloudy
	26.36	47.0	.798	ditto	Ditto.
Midnt.	27.30	46.0	.772	ditto	Ditto.
	27.24	50.2	.750	SW	Light airs and cloudy.
	27.24	39.0	.791	NW	Strong breezes ditto.

Mean Daily State of Variation, August 13—21.

DATE.	A.M.	P.M.	Mean.	Barometer	
Aug. 13.	26.30	27.23	26.56	29.540	
14	27.17	27.21	27.19	.422	Mean by A.M. Obs. 26.40.0
15	26.59	27.7	27.3	.404	P.M. .... 27.1 .20
16	26.32	27.8	26.50	.531	Diff. 21.20
17	26.33	26.55	26.44	.641	
18	26.27	26.29	26.28	.640	
19	26.28	27.3	26.45	.771	
20	26.32	26.52	26.42	.708	
21	26.42	26.54	26.48	.767	
Mean	26°.40′.0″	27°.1′.20″			

The great irregularity in the results of these observations in the course of a few hours is very remarkable, particularly the three first, a difference occurring of about 3°, as no change of circumstances at all affecting the needle ever took place in the tent during the interval of these observations, and every possible care was taken to remove iron from the place. The instrument was likewise referred to the meridian mark, before and after each observation. There likewise appears to be generally an increase of atmospheric pressure corresponding to an increase of westerly variation. A similar analogy is likewise very apparent in the

magnetic force in this country, in accelerating the balance of a chronometer by means of a magnet. The chronometer used for this purpose was made by Arnold, which, besides the usual compensation for temperature in the balance, had a steel rim attached to it; and when the south pole of a magnet, fixed in the plane of the balance, was presented to it, an immediate acceleration of about 32″ in twenty-four hours was observed. The following are the rates I have been able to obtain by transit—

Rate in 24 hours M.S. time.	Barometer.	Intervals.
+ 13.″6	29.702	3 days
+ 14. 7	29.789	3 —
+ 16, 9	29.991	4 —
+ 14. 8	29.940	3 —
+ 16. 8	30.061	5 —
+ 17. 3	30.074	3 —
+ 14. 6	29.883	5 —

The chronometer had a very steady rate of — 15″.5, before the application of the magnet. These experiments, and likewise the effects produced on the acceleration by the violet ray, together with a comparison of the forces accelerating the oscillations of a dipping needle at Spitzbergen, Shetland, and London, I will give in another paper.

It appears now from the observations, that the afternoon variation, taken between noon and midnight, exceeds the morning variation taken between midnight and the following noon by 21′.20″. This excess is even apparent in the observations taken with the azimuth compasses on the ice, particularly with Kater's compasses, which, in point of lightness and delicacy of construction, far exceed the others. It appears from them by a mean of a great number of observations, made in the summer of 1818, that in lat. 80°. and long. 11°. E., the morning variation was 23°.49′. W., and the evening 24°.16′., making a difference of 27′.: the mean variation, therefore, in that latitude is 24°.2′.30″. W.

The following are the results of the observations made for

determining the magnetic dip with two dipping needles, made by Troughton and Jones.

DATE.	Latitude.	Longitude.	Dip.	No. of Observation.	REMARKS.
June 6th,	79°.34′.0″ N	11°.0′″ E	81°.2′. 0″	10	Noon, on shore at Magdalena Bay, Spitzbergen.
Aug. 12th,	79.40.20 N	11.7 E	81.2. 30	24	Noon, at the Observatory on Dane's Island.
June 13th,	79.50.0 N	12.0 E	81.46.0	16	Noon, on the ice at sea.
18th,	79.53.0 N	11.50 E	81.14.0	30	A.M. ditto.
——	——	——	81.23.30	60	P.M. ditto.
July 21st,	80.14.0 N	11.12.0 E	81.45.0	20	A.M. ditto.
——	——	——	81.50.0	36	P.M. ditto.

If the mean variation near the latitude of 80° N. alters at all in the course of time, it does not alter in any degree as it does in more southern latitudes; for the variation by Fotherby in Magdalena Bay in 1614, in latitude 79°.34′, was found to be 25°. W., and by Poole 18°.16′ W. in Cross Road in latitude 79°.15 N., in the year 1610.

In proceeding northwards above the latitude of 79°½, the variation was found by observation on shore and on the ice sensibly to decrease; and it further appears to be a maximum near the meridian of Greenwich, in about 66° N. latitudes, as far as can be deduced from ship azimuths.

Since, therefore, the westerly variation has been determined by observation sensibly to diminish above the latitude 80°, and that the magnetic dip also increases, which is very nearly equal to the latitude; it is plain that one of the magnetic poles must coincide nearly with the pole of the earth.

The state of atmospheric electricity in these regions, not only from the analogy of the aurora borealis and australis to electrical light, but also from its probable influence and connexion with the phenomena of the magnetic needle, was on this occasion an inquiry exceedingly interesting. The opportunities, however, which occurred, were from unavoidable circumstances, far from being as numerous as could be wished. The apparatus used for

the purpose, consisted of a long chain of copper connected to a rope by means of glass arms placed about a foot distant from each other; by means of this rope, one extremity of the chain terminated by a long tapering copper rod, tapered with platina, was elevated above the main-top-royal-mast-head.

On no occasion, however, but one, could the presence of electricity in the atmosphere be detected; this was on the 21st July, the ships were at that time firmly beset with ice on the north coast of Spitzbergen, in latitude 80°.15′ N.; during the whole of the day the electric chain conductor was attached to the main-royal-mast-head, and in the forenoon, which was perfectly calm, no symptoms of electricity was indicated by any of the electrometers, but in the afternoon negative electricity was detected; for, on applying a small gold leaf electrometer to the conductor, a divergence of the leaves took place, which was instantly increased by the application of a stick of sealing wax previously excited. Long diverging clouds from the eastward. By azimuths, taken immediately afterwards, the westerly variation was rapidly increasing, as appears from the following results of the observations taken at equal intervals of not more than ten minutes:—

° ′ ″	
22.54.66	W.
23. 4.40	—
23.20.2	—
23.53.52	—

Each of the observations is a mean of five azimuths, taken with Kater's azimuth compass, fixed on a tripod stand on the ice; the corresponding altitudes of the sun's upper and lower limb were taken alternately by myself and Mr. Dealy of the Dorothea, with Troughton's eight-inch sextants and false horizon. This rapid increase in the variation at the time of detecting the electricity, is exceedingly remarkable. The weather was perfectly calm, and the sun's altitudes were taken under the most favourable circumstances; nor can it be attributed to any extraordinary refraction in the atmosphere, which appears by

comparing the sun's noon and midnight meridional zenith distances*.

The aurora borealis was seen on our returning to England, exceedingly vivid, but no sensible effect was produced on the compasses.

Art. IX. *Observations on the Theory which ascribes Secretion to the Agency of Nerves. By* W. P. Alison, M.D. F.R.S.E., *&c. Professor of Medical Jurisprudence and Medical Police in the University of Edinburgh.*

[Communicated by the Author.]

The importance of Dr. Wilson Philip's Experimental Inquiry into the Laws of the Vital Functions must be obvious to all who study, with the attention it deserves, his refutation of the theory of Le Gallois, concerning the connexion of the nervous system, in the living body, with muscular action, contained in a work which the French National Institute characterized as "certainly the most important which has appeared in physiology since the learned experiments of Haller," and the doctrines of which that learned body, somewhat hastily, sanctioned and adopted.

The most prevalent opinion in the schools of medicine, in regard to the connexion of the nervous system with muscular action, has been, that the muscles derive from the nerves, not merely occasions of irritation, but supplies of irritability, in the

---

* The apparent meridional zenith distances of ⊙ centre at noon and midnight, observed by Lieutenant Morell and myself, were, at noon, 59°.38.'6″, and midnight 79°.10'.57″,4.

		° ′ ″
If A =	obs. Z.D. ⊙ centre at noon corrected for Parallax ..	=59.38.6
a =	do. .... at midnight	=79.10.57,4
d =	⊙ declin. corresponding to A corrected for long...	=20.35.1
d' =	Ditto .... a	=20.29.10
r =	refraction of the tables corresponding to A	= 0. 1.37
r' =	ditto .... a	= 0. 4.51
x =	True refraction corresponding to A	
x' =	ditto .... a	

Then since $x+x'=180°-(A+a+d+d')=m$

and $x : x' :: \text{Tang.}\ (A-3r) : \text{Tang.}\ (a-3r')$

$$\therefore\ =x\ \frac{m.\ \text{Tan.}\ (A-3r)}{\text{Tan.}\ (A-3r)+\text{Tan.}(a-3r')}=1'.39''.$$

$$x'=\frac{m.\ \text{Tan.}\ (a-3r')}{\text{Tan}\ (A-3r)+\text{Tan.}(a-3r')}=4'.57''.$$

nearly the same as the refraction in the tables, at the mean temperature and pressure.

shape of nervous influence or energy. And the difference between the two sets of muscles, has been referred by some to the different parts of the nervous system, from which their respective portions of energy have been conceived to be derived. Thus Willis and Boerhaave derived the energy of the voluntary muscles from the brain, and of the involuntary from the cerebellum; Whytt and Cullen, that of both from the brain generally; Bichat, that of the former from the brain, and that of the latter from the ganglia of the sympathetic nerve; Le Gallois, that of the former set of muscles from the nerves immediately supplying them, and that of the latter from the spinal marrow; and, in some late French physiological works, reference is made to an opinion of Reil, which may perhaps be considered as the last hold of the doctrine of nervous energy, namely, that all muscles derive their irritability from the coats of the nerves immediately supplying them.

These opinions have led to much false reasoning in regard to the nature of various diseases; and therefore it is of the utmost importance to medical science, that we should be in possession of facts illustrating the true nature of the connexion between the nervous system, and the different muscular actions which constitute so important a part of all the functions of the living body. The experiments and observations of Dr. Wilson Philip on this subject, agree perfectly with those recorded by Haller, in his *Elements of Physiology*, and in his long controversy with Dr. Whytt, and appear to place beyond all doubt the general correctness of the doctrines which he taught in this fundamental department of physiology.

The following may be stated as the most important propositions which these physiologists have established.

1. "That the power of the muscles, both of voluntary and "involuntary motion, is independent of the nervous system;" that is, that no muscle, voluntary or involuntary, derives any thing from the nervous system, which enables it to contract. And, therefore, that the term nervous influence or energy in this, the most common sense in which it is employed in physiological and medical writings, is absolutely without a meaning.

2. That many muscles are directly excited to contraction by causes acting on the nervous system. And,

3. That the contractile power of all muscles may be much and variously modified, and in some instances destroyed, by causes acting on the nervous system*.

If these principles be correct, we see the necessity, in all investigations concerning the nervous system, of keeping steadily in view a principle which no train of reasoning is necessary to establish, but which has often escaped the attention of those engaged in such inquiries.

---

* That changes in the nervous system affect muscular action in *both* these ways was distinctly pointed out by Haller, in the same paper in which he controverted the doctrine of the dependence of muscular irritability on nervous influence, although the French reporters on Le Gallois's work seem to have supposed that, according to him, changes in the nervous system can only act in one way upon muscles, *viz.*, by directly stimulating them, and therefore that, in his apprehension, the nerves of the heart must have been absolutely useless. " Un jour," says he, " peut être, l'on reduira l'usage " des nerfs, par rapport aux muscles, a leur porter, de quelque façon que " la chose se fasse, l'impression des volontés de l'ame, et à *augmenter cette* " *tendance naturelle, que les fibres ont déjà par elles mêmes, à se contractir***."

And again, " minime improbabile est, etiam cordi per nervos vim motricem " accedere, quæ motum, *a natura irritebili* pendentem, *fortiorem et celeriorem* " efficiat††." It is impossible to express more clearly that the muscular power of the heart, although dependant only on its irritable nature, or as Dr. W. Philip expresses it, perhaps less correctly, on its mechanism, is liable to increase, and we may add, to diminution, from causes acting on the nervous system. I apprehend, therefore, not only that Haller has not overlooked the use of the nerves of the heart, but that he has stated their use more correctly than any physiologist since his time.

The experiments of Dr. Philip have illustrated more fully than those of any other physiologist these *two different modes*, in which changes in the nervous system affect muscular action. The general results of his observations, and of those of Haller, Bichat, and others on this subject, may be stated to be, that the *first* mode of action, that is, the direct excitation of muscular fibres to contraction by impressions made on the nervous system, is confined to the *voluntary* muscles ; and that the *second* mode of action, that is, the alteration of the vital power, or tendency to contraction of muscular fibres by impressions made on the nervous system, is chiefly exerted on the *involuntary* muscles.

Dr. W. Philip has indeed recorded in the second chapter of the second part of his work, some very important experiments which he considers as

** *Dissert. sur l'Irritabilité*, p. 52.

†† *Elem. Physiol.* Vol. I. p. 493. See also Vol. IV. p. 516.

When a change is produced in any of the functions of the animal economy, by means of a change effected in the nervous system, two explanations of the fact immediately present themselves.

It may either be supposed, that the ordinary exercise of the function affected is dependant on some particular condition of the nervous system, and, of course suffers a change corresponding to that which the nervous system undergoes; or, without any such habitual dependence of the function affected on the nervous system, it may be supposed liable to change from changes in that system. The former supposition is perhaps the more obvious of the two; but there is nothing in the nature of things to prevent the latter from being the true one, it being just as probable *à priori*, that muscular actions, or secretions, taking place independently of nerves, should be *liable to modification*, from changes produced in nerve, as that that power, so totally different from any possessed by nerves themselves, should be *dependant* on any influence which nerves can supply.

Unless, therefore, we have an *experimentum crucis*, to determine which of these explanations, in any particular case, is the true one, we are not entitled, from seeing an alteration, or even the cessation of any function of the animal economy, brought about by changes in the nervous system, to infer the dependance of that function, in ordinary circumstances, on any thing derived from the nerves.

Thus, Le Gallois was not entitled to conclude, from seeing the action of the heart stopped in his experiments, by sudden destruction of the spinal marrow, that the ordinary actions of the heart are dependant on, or its life derived from, the spinal marrow; because, without making that supposition, we can

---

proving that the heart may be directly simulated by impressions made on the nervous system. But although the term stimulus was very naturally applied by him to the substances which quickened the action of the heart when applied to the brain or spinal marrow, yet various considerations might be stated to shew, that the effect of these substances is more correctly expressed by saying, not that they excited contractions of the muscular fibres of the heart, but that they increased the tendency of the muscular fibres of the heart, to contract from the stimulus of the blood.

suppose it subject to change, from changes in the condition of the spinal marrow. In that case, an *experimentum crucis* in favour of the *latter* supposition was afforded, by the observation of Dr. Wilson Philip, that the *gradual* destruction of the spinal marrow, or its removal from the body, is not attended with any such change on the action of the heart.

The principal stated above has been fully recognised by Dr. Wilson Philip, in reference to involuntary muscular action, but he seems to me to have overlooked it in his speculations on secretion and animal heat.

After having seen reason to think, that muscular irritability, although often influenced through the medium of nerves, is in no case dependant upon any influence derived from the nervous system, I think we may go a step farther in laying down the fundamental principles of this kind of inquiry.

Whatever other purposes the nervous system may be destined to serve in the animal economy, it seems obvious, that it is intended to serve as a medium of communication between mind and body, and that all the changes in the bodily functions which are observed to follow mental acts, are produced through its intervention.

It is generally agreed among physiologists, and I think it cannot be doubted, that some *physical change* is produced in the nervous system by every mental act which, through its intervention, influences any bodily function. If this be so, it may naturally be expected, that these changes in the nervous system may be readily *imitated* by the application of physical agents, which furnishes a ready explanation of the effect of such agents, applied to the nervous system, on the various functions. And, therefore, when any effect is observed in any function from the application of physical agents to the nervous system, analogous to the changes produced in the same function by mental acts or affections, instead of arguing from that fact, the necessary dependance of the function in question, on any influence derived from the nervous system, it seems more reasonable merely to suspect that those physical agents must have wrought a change on the nervous system, somewhat ana-

logous to that, which these mental acts or affections had been wont to produce.

The opinion, that secretion is dependent on nervous influence or energy has been maintained by different authors; but the best arguments in favour of it are those which have been lately stated by Sir Everard Home *, Dr. Wollaston †, Mr. Brodie ‡, and Dr. Wilson Philip §.

Of these the most important is derived from the observations of the two last authors, on the effect of dividing the eighth pair of nerves, on the secretions of the stomach. Dr. Philip found, that no change takes place on food that has been recently taken into the stomachs of rabbits, on which this operation is performed, even when they live twenty-six hours after the operation, implying that the gastric juice had not been secreted. This is confirmed by the observation of older experimenters, that in animals killed by the division of the eighth pair of nerves, the contents of the stomach are found putrid: the effect, I presume, of their remaining some time at the temperature of the internal parts of the body, without being acted on by a chemical solvent. (See *Haller, Expériences sur les parties sensibles et irritables,* No. 182 and 185.) And Mr. Brodie found that the ordinary effect of arsenic, to produce an increase of the mucous and watery secretions of the stomach and intestines, is prevented from taking place, by dividing, either those nerves in the neck, or the branches of them which supply the stomach on the lower part of œsophagus ‖. From these experiments, these authors conclude, that the secretions of the stomach, and other parts, are dependant on an influence derived from their nerves.

According to the principle above laid down, the facts just

---

* *Philosophical Transactions* for 1809.

† *Philosophical Magazine* for 1809.

‡ *Philosophical Transactions* for 1814, p. 102.

§ *Expl. Inquiry*, &c., p. 119, et seq.

‖ He had previously found the secretion of urine to cease after the spinal cord is divided in the neck, or the head removed, both in rabbits and dogs; notwithstanding that the circulation is kept up by artificial respiration. See *Philosophical Transactions* for 1811.

mentioned, although obviously susceptible of explanation in this manner, are not sufficient to justify this conclusion. Without supposing the secretions of the stomach to *depend* upon any thing derived from the nervous system, we may suppose them *liable to change*, or even to total annihilation, from *certain lesions* of that system. And although the kind of lesion which produces this effect on these secreting organs be different from that which stops the movements of the heart; yet as we are ignorant of the manner in which any lesion of the nervous system affects muscular action or secretion, we are not more entitled to conclude, that the secretions of the stomach depend on its nerves, from finding them stopped by the division of these nerves, than Le Gallois was, to conclude that the action of the heart depends on the spinal marrow, from finding it stopped, in his experiments, by crushing that organ.

If the conclusion in question does not necessarily follow from the experiments, we are justified in refusing our assent to it, without pointing out any other manner in which the results of these experiments may be explained. Different theories may perhaps be formed for this purpose, but there is one consideration that appears to me particularly deserving of notice. The eighth pair of nerves are generally regarded as those which are most concerned in the *sensations* of the stomach. Now it is pretty certain that different secretions are very dependant on certain sensations. No one can doubt of the effect of the sensation of grateful food in the mouth, upon the action of the salivary glands. I think it cannot be doubted, that dividing the nerves of the tongue and palates, and so paralysing the organ of taste, would greatly diminish the flow of saliva during the mastication of food; but we know that the salivary glands cannot derive any energy from these nerves, because they are supplied by other nerves. By dividing the eighth pair of nerves after an animal has taken food; the natural sensations which accompany and succeed the recedtion of food into the stomach are prevented from taking place, and the painful sensations of dyspnœa and nausea are produced, and may not this be sufficient to explain the failure of secretion

in the stomach? The same supposition, of diminution, or destruction of sensation, and of the substitution of sensations of a different kind, may explain the want of any increased secretion from the action of the arsenic in Mr. Brodie's experiments.

When, therefore, Mr. Brodie concludes, from these experiments, that "the suppression of the secretions was to be attri-"buted to the division of the nerves," and "that the secretions "of the stomach and intestines are very much under the con-"trol of the nervous system," his inferences must command general assent. But when he hazards the farther conclusion, that "the secretion was prevented in consequence of the ner-"vous influence having been interrupted," I would beg to ask, what is the precise meaning attached in this instance to the term nervous influence, and what proof there is of its having been interrupted?

If it be meant merely, that the nerves are prevented from performing their accustomed actions, in regard to secretion, we may object to the expression, because it seems to imply, that these actions are constant and essential to the effect, whereas it is very possible that they may be only occasional, and may modify, without assisting, the secreting actions.

If it be meant that some influence derived from the nervous system really essential to secretion is cut off by the operation, we may object to the conclusion, because the fact may be equally well explained by supposing the lesion of the nerves to communicate a noxious influence to the secreting organ, without intercepting a salutary one.

The other arguments in favour of the dependance of secretion on the nervous system, chiefly insisted on by the authors formerly mentioned, are these:

1. Changes in the blood, somewhat similar to those produced by secretion, particularly the coagulation of the albuminous and the separation of the saline part, may be produced by galvanism.

2. Galvanism is excited by the contact of the nerve and muscle of an animal recently dead, and a galvanic pile may be formed of alternate layers of nervous and muscular substance.

3. The action of nerves on muscles is similar to that which is exercised by galvanism on muscles.

From these facts it is concluded, that what has been called nervous influence or energy is in all cases galvanism, and from them, taken in connexion with the facts just noticed, of the cessation of secretion on the division of the nerves supplying certain secreting organs, a strong presumption is thought to arise, that secretion is owing to a galvanic action propagated along the nerves, and is to be numbered with the other well-known chemical effects of galvanism.

In regard to secretion, a still stronger argument in favour of this theory is adduced by Dr. Wilson Philip. He found, that when the secretion in the stomachs, either of rabbits or dogs, is suspended by cutting the eighth pair of nerves, it may be restored by applying galvanism, and the ordinary changes may be effected by the help of this agent, on the food previously taken into the stomach.

It is obvious, however, *(taken for granted that all sources of fallacy in these experiments were avoided,)* that even this fact admits very readily of a different explanation. It may be said that the secretion in the stomach does not depend on its nerves, but is liable to be influenced through them; that the shock of the division of the nerves acted as a powerful sedative, and suspended the secretion, but that the stimulus of the galvanism was sufficient to restore it.

It is obvious also, that if this last explanation be admitted, these experiments of Dr. Philip must be regarded as furnishing a decisive argument *against* the dependance of secretion upon the nervous system. For here we have the nervous influence cut off, and yet secretion going on. On the supposition that the nervous influence is really essential to secretion, this can only be explained by supposing the galvanic influence, which is substituted for it, to be really the same thing.

If, therefore, we can make it probable, that the changes which occur in the nervous system are not galvanic actions, we need go no farther, after these experiments, in order to shew that the nervous system is not necessary to secretion.

But, on the other hand, even if we admit the galvanic nature of nervous actions *, it does not follow from these experiments that they are essential to secretion; for the effect of the galvanism, applied in these experiments of Dr. Philip, may be merely to counteract a noxious influence resulting from the division of the nerves, not to restore a salutary one.

I shall first state the considerations which seem to me to render it probable that the actions of nerves are not galvanic, and afterwards those which seem to me to shew, that even if nervous actions be galvanic, still they cannot be necessary to secretion.

I. It is not, of course, intended to deny, that a certain degree of galvanic action may be excited by the contact of nerve and muscle, or of nerve and gland; that these substances stand related to each other as the zinc and copper of a galvanic trough do. What is doubted is, not the presence of the cause assigned, but its adequacy both in degree of intensity, and in kind of agency, to the explanation of the phenomena, and that for the following reasons:

1. If the changes in the nerves, which precede the contraction of muscles irritated through their nerves, be of the nature of galvanism, and if it be by galvanising the muscles that all the stimuli applied to nerves excite these motions, we must suppose galvanism to be excited, from time to time, to an intense degree, in nerves and muscles, without the aid of any chemical agent, and without any change in the chemical constitution of these parts taking place either during or after the evolution of the galvanism. Now it is quite clear, that in tracing the physical changes produced by mind on body upwards to their source, we must ultimately arrive at some physical change which is inexplicable; and this ultimate inexplicable change may just as well be of the nature of galvanism as of any other nature. I do not therefore urge it as an argument against nervous actions being gal-

* In this paper I use the term "nervous actions" as a short expression for those unknown changes in the nervous system, which are presumed to take place on various occasions in the living body, without presuming to offer an opinion as to the nature of these changes.

vanic, that we cannot understand how the *mind* should excite under these circumstances strong galvanic actions in the nerves. But the important fact is, that nervous actions may be very readily excited by various *physical* agents, which certainly have no effect whatever in exciting galvanism in any other apparatus. Farther, these actions may be excited in the nerves, long after their communication with the brain, (which is supposed on this theory to be the main source of galvanic energy,) is cut off; muscles being excited to contraction by stimuli applied to their nerves fifteen days at least, according to the observation of Haller after the division of these nerves above the point irritated.

If, indeed, it were ascertained as matter of fact, that the irritation of muscles through their nerves is always attended with a notable evolution of galvanism, though it might be very difficult to explain the fact, it would be fair to argue, that the galvanism, known to be evolved, was the cause of the contraction; but in the present state of our knowledge on the subject, there being no proof whatever, that more galvanism passes from nerve to muscle during the contraction produced by irritation than at any other time, it seems to me fully as probable that muscles should be so constituted as to contract in consequence of imperceptible changes, not galvanic, communicated to them by their nerves, as that galvanism should be excited to a most intense degree in nerves, merely by bruising them with a probe, or pricking them with a pin, particularly after their communication with the source whence they are supposed to draw their galvanism is cut off.

2. The effects which are produced upon muscles by changes in the nervous system, are much more various than those which have ever been observed to result from galvanism. Stimuli applied to the nerves supplying the voluntary muscles, excite them very readily to contraction, but I believe no physiologist has ever succeeded in exciting the involuntary muscles to contraction, by applying stimuli to their nerves. Galvanism applied to either set of muscles directly excites them with nearly equal facility. Alcohol applied to the brain augments the irritability of

the heart; an infusion of tobacco applied to the brain diminishes it. We may admit that galvanism is a power capable of producing both these kinds of effect on muscular organs, according as it is applied in a greater or less degree of intensity; but have we any reason to suppose, either that these two substances, acting on nervous matter, can excite galvanism at all, or that they can excite it in so very various degrees of intensity?

These considerations seem sufficient to shew, that we cannot suppose the action of nerves on muscles to be of the nature of galvanism, without supposing a much greater variety in the modes of exciting galvanism, and, in its effects on muscular organs, than any observations on this power entitle us to assume.

3. If we suppose, with the authors of the galvanic theory of nervous actions, that these actions are essentially concerned in secretion, a strong argument against their identity with galvanism arises from the fact, that the various secreted fluids are so different from each other. This difficulty increases greatly, when we take into account the nutrition of all the different textures in the body, a process which Haller has well characterized as "omnium amplissima secretio." If there be powers in the animal economy distinct from galvanism, which are sufficient for the formation of the *solids* of the animal body, out of the blood, it is quite obvious that these powers must be amply sufficient for the formation of the secreted *fluids* out of the blood, and it is therefore quite unnecessary to suppose galvanism concerned in this last process. But if we regard both secretion and nutrition as dependant on galvanism, transmitted through the nerves, and refer to this cause the formation of all animal substances, from bone to serum, out of the blood, then, I think, we must make one of two suppositions. Either we must suppose the galvanism transmitted by the nerves to the various parts of the body, to be different in its nature in different places; or we must suppose the blood to undergo very various preparation in the different parts of the body, before it is submitted to the action of the galvanism.

In the former case, our explanation is contradicted by all

that we know of galvanism, there being nothing to make us suppose that the blood can be differently affected by galvanism passing through two different sets of nerves; and certainly nothing that we know in the structure or composition of the different nerves, induces us to suppose that the nature of the galvanism sent through them can be different.

In the latter case our explanation only begins where the real difficulty ends. If there be powers in the animal system sufficient to prepare the blood so variously, that one chemical agent thereafter operating on it, shall form out of it bone, muscle, tendon, oil, and serum, those powers must surely be adequate to the formation of these different substances without farther help; or at least it is to those powers, and not to the agent subsequently applied, that by much the greater share of the phenomena of nutrition and secretion must be ascribed.

It may be said, that although we have no proof of galvanism being excited in nerves by the application of stimuli, to such a degree as can explain the irritation of muscles through nerves; and have no proof of galvanism being so different in different situations, as to be capable of producing effects so different from each other as the formation of bone and of serum out of the same blood,—still all this may be true of galvanism; and we know so little of that power, that we are not entitled to lay down the limits, either of its developement or its action. To this I would answer, that it will be time enough to regard galvanism as identical with nervous actions, when it shall be proved, that it may be excited by as various means, and may produce as various effects.

To explain a set of phenomena in nature, is to establish their coincidence with another set of phenomena more general and better known. How then can we be said to explain the phenomena of the nervous system by resolving them into the phenomena of galvanism, when it is only by a hypothetical extension of these last phenomena, that they can be made to include the former, and when it is only in consequence of our ignorance of their real nature and limits, that we can venture upon this hypothetical extension?

4. Another circumstance which seems to me very adverse to the supposition, that division of the eighth pair of nerves, and division of any nerve supplying a voluntary muscle, act on the secretions of the stomach and the motions of the muscle equally by cutting off a supply of galvanism, is this, that no secretion at all takes place after the former operation, whereas powerful muscular contractions may be excited by applying stimuli to the nerve below the point of division long after the latter. According to the galvanic theory, these contractions are excited by galvanism, remaining in the nerve after its division*. Why, then, does not galvanism enough remain in the nerves of the stomach after the division of the eighth pair, to carry on digestion for a certain length of time?

These considerations seem to render it extremely doubtful whether the changes which take place in the nervous system and affect the muscular or secreting organs, or the nervous actions, can be of the nature of galvanism; and if they be not galvanic, Dr. Wilson Philip's experiment above referred to, becomes an *Experimentum Crucis* against their being essential to secretion.

But, even if the actions of nerves be galvanic, there are very strong reasons for thinking that they cannot be essential to secretion and nutrition.

1. The secretion of the stomach was found to be suppressed, in Dr. W. Philip's experiments, by other lesions of the nervous system besides cutting the eighth pair of nerves. It was suppressed in rabbits nearly or entirely by destroying the lower half, or even less than the lower half, of the spinal marrow. (See Expts. 58, 59, 60, p. 171.) In these cases the stomach must still have had the supply of galvanism which it receives through the eighth pair of nerves, and in fact all that it receives from the brain and upper half of the spinal marrow, a much greater supply than that, the interception of which in the former experiments was supposed to stop the secretion. Where we find so great an effect produced on the secretion of the stomach by a cause which, even on the supposition of its deriving galvanism

* See Haller, *Mém. sur les Parties Sensibles et Irritables*, Exp. 201, 202, 214, 220,—225, and p. 237.

through its nerves from the brain and spinal marrow, can only have intercepted a small portion of that galvanism, it is surely reasonable to suspect, that the effect is to be explained on other principles than the interception of galvanism or of any other influence essential to secretion derived from the nerves.

is likewise particularly worthy of notice, that the secretion urine, although it was found to be destroyed, in Mr. Brodie's experiments, by division of the spinal marrow at its upper part, was not affected in these experiments of Dr. Philip, by the destruction of the lower half of that organ. I believe it will be allowed, that the kidneys have at least as much communication with the spinal marrow by their nerves as the stomach has : and therefore, when we find the secretion of the stomach suppressed by an injury of that organ, which does not affect the secretion at the kidneys, it seems fair to presume, that it is not by intercepting an influence *essential to secretion* that the injury produces the former effect.

2. This suspicion must become much stronger when these cases of suppression of the secretion of the stomach, from the destruction of part of the spinal marrow, are contrasted with the cases, of which there are many on record, of destruction of large portions of the brain, which is supposed in this theory to be the main source of nervous influence, without any affection of the functions of secretion and nutrition. For an enumeration of cases of this kind I refer to the review of Sir Everard Home's late paper on the functions of the brain in Vol. XXIV of the *Edinburgh Review*. When we find the secretions of the stomach nearly destroyed by sudden destruction of a part of the spinal marrow, and not at all affected by gradual destruction of nearly the whole brain, we surely cannot consider the former cause to operate merely by cutting off a supply of nervous influence coming from the brain and spinal marrow, but must regard it as more probably on the same footing, with regard to secretion, as the destruction of the spinal marrow in Le Gallois's experiments, with regard to circulation, on which Dr. Philip himself has so judiciously commented; that is, as exemplifying, not a continual and essential agency of changes in the nervous

system upon the function of secretion, but an occasional and controlling agency.

3. But what appears to me to remove all doubt upon this subject is the class of facts (very candidly acknowledged, but I think not duly weighed, by Dr. Philip,—*Experimental Inquiry, &c.*, p. 240,) in regard to secretion and nutrition taking place where nervous influence cannot be supposed to operate; in vegetables, in the animals in which no nervous system has been discovered, in the chick *in ovo* before any vestige of the brain and spinal marrow can be traced, in the early part of the existence of the human fœtus when the brain and nerves appear incapable of performing their functions,—but most of all, in the cases, which are reported on unquestionable authority, of fœtuses born alive without either brain or spinal marrow.

Dr. Philip gets over this difficulty by supposing that there may be some other apparatus, in all these cases, by which galvanism may be applied to the blood, and which may therefore supply the place of the nervous system. But this is obviously supporting one hypothesis by means of another and a much bolder one. That galvanism is at all concerned in secretion or nutrition is a hypothesis which rests fundamentally upon two suppositions, that galvanism is identical with nervous influence, and that nervous influence is essential to secretion. If we put nervous influence out of the question, we have no better evidence of galvanism being at all concerned in secretion than merely this, that it produces chemical effects on the blood, and in particular coagulates its albumen, effects which are equally produced by caloric and various other chemical agents, and which never can be considered as amounting to a proof of secretion depending upon galvanism. When, therefore, we adduce even a single instance of secretion taking place independently of any influence that can be derived from the nervous system, we cut away at once the very foundation of the hypothesis which attributes secretion to galvanism; and although the hypothetical explanation of such instances, by galvanism supposed to be drawn from another source, given by Dr. Philip, may possibly, in the progress of knowledge, turn out to be

correct, yet I think we may say with confidence, that in the present state of our knowledge it is not philosophical. The proper conclusion from the examples of secretion and nutrition going on independently of nervous influence should have been, not to suggest an additional hypothesis that another influence equivalent to that of nerves may be applied, but to invalidate the hypothesis formerly entertained, that nervous influence is essential to secretion.

Abstracting from the rare occurrence of the fœtus without either brain or spinal marrow, the *fœtus acephalus*, of which many examples are recorded, appears a sufficient answer to the conclusion drawn from the experiments both of Dr. Philip and Mr. Brodie. In the child of whom we have an account by Mr. Lawrence in his paper in the *Medico-Chirurgical Transactions*, Vol. V., p. 165, there was neither brain nor cerebellum. This child lived four days, and the secretions from its stomach, bowels, and kidneys, seem to have been quite natural. Surely this is sufficient to shew that the division of the eighth pair of nerves, and of the spinal marrow in the neck, which stopped the secretions of gastric juice, and of urine in those experiments, could not have acted by cutting off an influence, essential to secretion, coming from the brain.

4. If any farther proof be required, that the conclusion drawn from the experiments of Mr. Brodie and Dr. Philip of an influence derived from the nervous system being essential to secretion, is not warranted by the facts already known on the subject,—I think it is afforded, as has been already stated, by Mr. Lawrence in the paper above referred to, p. 223, by the experiments of these authors themselves. In animals in which the eighth pair of nerves is divided, the bronchiæ and air-cells of the lungs are always found, as Dr. Philip expresses it, "clogged with a frothy mucus," which prevents the lungs from collapsing when the thorax is opened after death, and which, by preventing the application of air to the blood in the lungs, appears, from the observations of Dr. Philip, Le Gallois, and others, to be the immediate cause of the death that succeeds that operation.

Now this frothy mucus, found not only in the air-cells, but in the bronchia, in a quantity so much greater than natural, as to be the cause of death,—what is it but a secretion? If it be denied that the fluid which is effused on the membrane lining the bronchia and air-cells be a secretion, it is not worth while to dispute about the word; but it appears to me obvious, that it is a formation from the blood, so much akin to the formation of the stomachic juice that the two must depend upon the same principles. And when we find, in the experiments in question, that the division of the eighth pair of nerves, which supply equally the lungs and the stomach, diminishes or destroys the production of the one of these fluids, and increases that of the other, it is surely preposterous to conclude, that these experiments demonstrate the necessity of an influence, derived from the nerves, to secretion in general.

There is a series of experiments by Mr. Brodie, (*Philosophical Transactions* for 1812, p. 378,) intended to prove, that in an animal which has been either killed by decapitation, or stupified by poison, in such a manner as apparently to suspend all the functions of the nervous system, the evolution of carbon still goes on at the lungs, to an equal extent as in a healthy animal, when artificial respiration is employed. To this evolution of carbon, Mr. Ellis has given the name of secretion; and although I do not pretend to decide whether that name is applied with perfect propriety in this instance, I take leave to observe, that this process, thus proved to go on notwithstanding the division, or destruction of the functions of the nerves supplying the organ concerned in it, is considered by that distinguished physiologist so nearly akin to secretion as to deserve the same name. Its continuance, therefore, even independently of the increase of the formation of mucus, in these circumstances, must be regarded as a very strong argument against the dependance of secretion on nervous influence.

Having thus considered the different arguments in favour of the supposition of that dependance, I think we may fairly say not only that there is no proof of it in the writings of physiologists, but that there is strong evidence against it. I need

hardly add, that if we suppose the nervous system to be destined to exercise over secretion, as well as over muscular motion, *not an uniform and essential,* but an *occasional and controlling influence,* and that particularly when itself is affected by mental acts or emotions, we shall be at no loss in explaining the phenomena which have been thought to denote the dependance of secretion on the nervous system. The secretions of the stomach in particular, are so notoriously under the control of various affections of the mind, (acting on them, in all probability, through the medium of its nerves,) that it cannot appear surprising, that they should be very much deranged by division of these nerves.

Dr. W. Philip's opinion, in regard to the connexion of the nervous system in the living body with muscular action, which appears to me to be perfectly correct, may be thus stated; That when the nervous system is itself impressed by various agents, mental and physical, it is capable either of exciting or of variously modifying the actions of all the different moving solids of the body; but that, when not itself impressed by any of these agents, it appears from all that we yet know on the subject, to be absolutely passive and inert in regard to all these moving solids.

The considerations which I have now stated appear to me sufficient to shew, that the same conclusion may be extended to the connexion of the nervous system in the living body with secretion; and in another paper I shall endeavour to shew that we have good grounds for forming the same conclusion in regard to its connexion with animal heat.

Art. X. *Some Account of* Messrs. Perkins *and* Fairman's *Inventions connected with the Art of Engraving.*

Among the numerous discoveries and inventions that have adorned the present age, there are certainly none of more interest or importance than those of which we propose to give a brief account in this article; indeed they form an epoch in the history of the fine arts, and display a degree of skill and ingenuity in overcoming the various difficulties that must have

presented themselves, and which are neither light nor few, infinitely creditable to the artists concerned.

Through the kindness of Mr. Perkins we have been enabled to examine his sidero-graphic process in all its parts: and we think that, independent of its other merits, it may be considered as especially important in relation to the great and increasing crime of forgery;—a crime which it is doubtless impossible to prevent, but which is at present so easy of execution and difficult of detection, that he who increases the obstacles and doubles the difficulties opposed to so heinous an offence, must be considered as not less deserving of the thanks of his country than of mankind in general.

Mr. Perkins's plan is briefly this. He has discovered a peculiar method of rendering steel extremely soft and sectile, so as to furnish a better material for the engraver to work upon than even copper itself. Upon a plate of steel thus softened, we will suppose an engraving has been executed by one of our first artists, at considerable labour and expense; it is then returned to Mr. Perkins, who by a process as peculiarly his own as the former, renders it as hard as the hardest steel, without in the smallest degree injuring even the most delicate lines of the graver. A cylinder of *soft* steel is then prepared, of proper dimensions to receive an impression *in relief* from the hardened engraved plate, upon its periphery, a process effected by rolling it over the hardened plate in a singularly constructed press, invented by the patentees for the purpose. This cylinder, now bearing a perfect impression in relief of the original engraving, is next submitted to the hardening operation, and is then ready for use: that is, being properly placed in the press, it is rolled over a plate of copper, upon which it indents any required number of copies of the first engraving, every copy thus produced being of course a perfect fac-simile of the original. So that in this way any number of copper-plates may be engraved in a very short time, from an original of the most exquisite workmanship, each of which, we believe we may safely pronounce, shall be quite equal to an original copper-plate engraving from the same hand, and of the same merits.

But the impression from the cylinder may be made, if required, upon soft steel, instead of copper, and this, afterwards hardened, becomes capable of affording an infinitely greater number of good impressions than the copper-plate; it may also be used as a new source of copies upon the cylinders, thus presenting a means of multiplying the engravings beyond precedent, and almost eluding calculation.

When it is remembered that all kinds of engravings, the finest, as well as the most common, may be multiplied upon the same principle, the utility and economy of the plan, where numerous impressions are required, will be at once evident; and a means is afforded of substituting, in a variety of publications requiring many copies of the same engraving, fine and perfect works of art, at the same expense which is now incurred for those of a very inferior description. The despatch too with which all this is effected is not one of the smallest merits of Messrs. Perkins and Fairman's very extraordinary invention; the specimen (Plate 2.) with which, through their assistance, we are enabled to present our readers, could certainly not have been produced in the ordinary mode of engraving in less than six months; whereas, by the process we are describing, it was indented upon the copper from the originals in less than half as many hours.

It will appear, from our specimen, that engine engraving, exhibited in the border at the top, and repeated at the bottom of the plate, may be combined with that of the artist, and the machine by which these are produced, appears, as far as our information goes, to be preferable to any that has hitherto been employed for the same purpose. It has the property of designing its own patterns or figures, and in such endless variety that they can only be compared to the whimsical and infinitely varied combinations presented by the kaleidoscope.

The border also exhibits another important operation of the engine, which consists in producing the engraving alternately indented and in relief, so as to imitate copper and wood engraving, every other link of the chain of which it is composed differing from its neighbour, by exhibiting white lines where the other is

black, and *vice versâ.* This inversion of the engraving by Mr. Perkins's engine throws very great difficulties in the way of imitators; the same object can scarcely be attained by any method except wood cuts, and the impossibility of imitating the delicate work which our plate exhibits, must be quite evident.

The most important light, however, in which we can view this new art of engraving, relates to its possible applications to the prevention of forgery.

It is a well known fact, that, independent of the expense and time necessarily attending the production of a fine copper-plate engraving, the wear of a plate is such, that a few hundred perfect copies can only be taken without re-touching it, which, when performed by the hand of the engraver, necessarily destroys the identity of the plate; but the immense number of impressions that would be required in applying fine engravings to the purposes of the Bank of England, is such as wholly to preclude any idea of the prevention of forgery, by the exquisiteness of a copper-plate engraving. Further, it must be admitted, that no artist can form an exact duplicate of any of his own engravings; and if it be impossible to make a perfect imitation even of his own work, how much less probable is it, that another person should execute such a duplicate. Supposing it, therefore, possible, that a very finely executed engraving could be multiplied to any extent, without chance of change, the forging of such an engraving could be detected by any person possessed of one of the originals, who would be at the trouble of carefully comparing the arrangements of lines and dots in both. This multiplication of the original by the production of any number of exact copies, is attained by the process above described, and the plate furnishes an instance of the perfect resemblance of the copies to the original, for if any two of the repeated engravings be very carefully inspected, it will be found that they are so perfectly similar as to bear all the characters of having been taken from one and the same plate: This is particularly shown in the centre medallion on each side of the plate, which contains the charter of the Bank of England, in very minute charac-

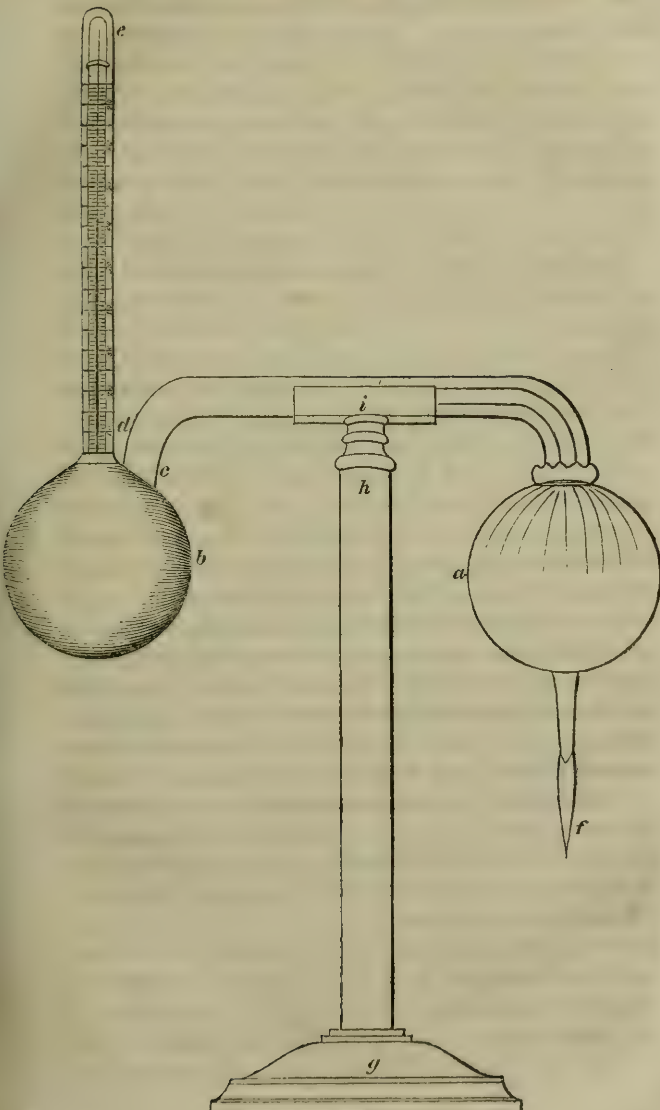
ters, and which presents peculiar difficulties to successful imitation.

We are inclined to maintain that no other system hitherto devised, in which the fine arts are employed, comes at all into competition with the present plan; and we need scarcely add, that in respect to bank notes printed in the usual way, identification is impossible, since no two plates of the same denomination are in all respects alike. In this remark we would by no means be considered as making the smallest allusion to the new plan adopted by the Bank, at the suggestion of the Commission appointed under the Great Seal for the purpose; and with the merits and nature of which we are entirely unacquainted.

If we suppose a bank-note, with a sufficient quantity of ornaments, or vignettes, executed upon the principle which we explained, we conceive that the receiver of notes may render himself nearly, if not absolutely, safe, by furnishing himself with an original impression of the engraved parts, by the close inspection of which he may surely determine whether the impressions upon the note are from the same plate; and forgers, knowing that every person may, if he choose, put himself in possession of the means of detecting the spurious note, will, probably, not be induced to risk so much with a trifling prospect of success, since those only who will not be at the trouble of informing themselves, can be imposed upon.

Art. XI. *On the new Hygrometer, by* J. F. Daniell, Esq., F.R.S. *and* M.R.I.

Being desirous of ascertaining whether the superior power of metals in conducting heat, together with the high polish of which they are susceptible, might not be rendered conducive to the perfection of the instrument which I described in the last number of the *Journal*, I endeavoured to modify its form in such a way as to allow of its being so constructed. After some trials I completed one which answered my expectations, and of which the subjoined is an outline.


e
d
c
b
i
h
a
f
g

The balls *a* and *b*, together with their connecting tube, are made of very thin brass. To the orifice *f* is soldered a small piece of platinum tube, which, from its property of welding with glass, allows of the junction of a piece of glass tube of the requisite length, which, after the instrument has been boiled as before directed, is hermetically closed in the usual way. The thermometer *d e* is so constructed that its bulb, which is enclosed in the ball *b*, is rather less than the diameter of its stem, which is made proportionably thick. It is ground air-tight into a collar of brass made for its reception on the top of the ball. The ball *a* is covered with thin muslin, and the ball *b* is very highly polished.

The great advantages of this form of the hygrometer are two.

First, It enables the observer to mark with the utmost precision the instant of the first precipitation of the vapour. The white mist is directly seen, whereas it requires a little practice to obtain an equal degree of certainty with the glass instrument, especially in hazy weather. The polish of the metal is easily preserved by means of frequent wiping with leather covered with a little whiting, but the hygrometer would be more elegant as well as less liable to tarnish if strongly gilt.

The second advantage is that its sensibility may be increased at pleasure, by extending the scale of the thermometer *d e*. The divisions of the thermometer included in the glass instrument are necessarily small, but those of the external thermometer may be made of any required magnitude without rendering the bulk of the whole too great.

I have continued my observations with the new hygrometer for another quarter of a year, as subjoined in the Meteorological Journal, and I shall now endeavour to draw two or three conclusions from the mean results of the experiments. The means of the half year are as follow:

Pressure of the atmosphere	29.765 ins.
do. of the vapour, ...	0.288
Weight of vapour in a cubic foot, ...	3.243 grs.
Degree of dryness, ...	3°.

Evaporation per minute from a surface six inches in diameter, ... 0.18 grs.

Temperature .... 40°.

But it is by comparing together the results of different periods that we shall obtain the information which we require. The whole term of my experiments is as yet but very limited; but by dividing it, short as it is, we shall obtain some curious points of comparison.

The means of the first quarter are as follow:

Pressure of the atmosphere, ...	29.770 ins.
Do. of the vapour, ...	0.355
Weight of vapour in a cubic foot, ...	3.944 grs.
Degree of dryness, ...	4½
Evaporation per minute from a surface six inches diameter, ...	0.32
Temperature, ...	48°.

The means of the second quarter are

Pressure of the atmosphere......................	29.760 ins.
Ditto of the vapour	0.222
Weight of vapour in a cubic foot.................	2.543 grs.
Degree of dryness	1½
Evaporation per minute, from a surface six inches in diameter..................................	0.05
Temperature	33°

By subdividing these again into half quarters we obtain, for the first period—

Pressure of atmosphere.........................	29.88 ins.
Ditto of vapour................................	0.429
Weight of ditto in a cubic foot	4.697 grs.
Degree of dryness	6¾°
Evaporation	0.50
Temperature..................................	56°

For the second period—

Pressure of atmosphere	29.63 ins.
Ditto of vapour................................	0.262
Weight of ditto in a cubic foot	2.988 grs.
Degree of dryness	1¾

Evaporation	0.08 grs.
Temperature	38°

For the third period—

Pressure of atmosphere	29.73 ins.
Ditto of vapour	0.219
Weight of ditto in a cubic foot	2.505 grs.
Degree of dryness	1°
Evaporation	1.03
Temperature	32°

For the fourth period—

Pressure of the atmosphere	29.79 ins.
Ditto of the vapour	0.225
Weight of vapour in a cubic foot	2.580 grs.
Degree of dryness	$1\frac{3}{4}$°
Evaporation per minute from a surface six inches in diameter	0.06
Temperature	34

It is curious to observe the progressive changes of the atmospheric vapour in these different divisions. These six months constitute the dampest half of the year, but dampness, we perceive, does not consist in the greater quantity of vapour in the air, but in the approximation to the point of saturation of the existing temperature. In the first six weeks, from the end of August to the middle of October, the weight of vapour in a cubic foot was, upon the average, 4.697 grs. and the mean degree of dryness $6\frac{3}{4}$. From the end of November to the beginning of January, the weight of vapour was not more than 2.505 grs., and the degree of dryness only 1°. Hence is apparent the reason why the quantity of rain is greater in the summer months than in the winter, although the number of rainy days is less. The dampest period of the year is from the middle of November to the beginning of January. From that time to the end of February, the dryness sensibly increased, and in March, it will be hereafter seen, has reached the average degree of the autumn month. Evaporation is in compound proportion to temperature and dryness, and, in the first six weeks,

amounted nearly to three times the quantity of the whole of the three remaining periods.

Again; from the mean of 178 experiments we learn, that the degree of dryness in the afternoon exceeds that of 10 o'clock in the morning by 1°, while the degree of dryness of the night falls short of the same by $1\frac{1}{2}$°.

The evaporation of morning, afternoon, and night are respectively as 16, 22, and 6, and the weight of vapour, in the space of a cubic foot, is less at night by 0.024 than in the afternoon. This latter effect arises, no doubt, from its precipitation upon the earth's surface, when cooled by radiation, and is the amount probably of the aqueous precipitations of dew and hoar-frost. The amount of the depression of temperature from radiation, from an average of 100 experiments, is 4° per night.

The greatest quantity of vapour observed during the half year was 6.863 grains in the cubic foot with the wind from the south-west, the least quantity 1.065 grains with the wind from the east.

I shall conclude with one observation upon the correction to be applied to barometrical measurements from the use of the hygrometer. In my last paper I suggested the application of this correction, and mentioned, as a case most particularly liable to be affected by it, the estimation of the heights of the Himáláya Mountains. I was at that time unacquainted with the temperature of the atmosphere at the two places of observation, and was reduced to supposition to elucidate the example. Since then these data have been furnished by the *Quarterly Review* *, and we may now make the calculation upon much surer grounds, and reduce the probability of error to much narrower limits. The observations made by Captain Webb on the crest or highest ridge of Nítee Ghaut, taken on the 21st of August, at three P.M., by the mean of four barometers, the thermometer standing at 47, gave a mean of 16.27 inches.

From a journal of the weather, kept by Colonel Hardwicke,

* *Quarterly Review*, No. xliv. p. 423.

at Dumdum, about fifty feet above the sea, it appears that on the two days preceding and two days following, the one on which Captain Webb observed the Nítee Ghaut, the state of the barometer and thermometer at two P.M., was as under:

		Inches.		Degrees.
August 19,	barometer	29.46	thermometer	88.
20,	———	29.46	———	84.
21,	———	29.48	———	85.
22,	———	29.48	———	84.
23,	———	29.65	———	81.
	Mean	29.51		84.4

The difference of elevation corresponding with the observation between the Nítee Ghaut and Dumdum is

16,764 feet.
+ 50 feet, Dumdum above the sea.

16,814 feet, height of the pass above the sea.

Now, if we allow $12\frac{1}{2}$ degrees as the probable point of dryness at the lower station, and 6 degrees at the upper, which we are warranted in doing from the foregoing experiments, the correction to be applied for the difference of the pressure of the vapour will stand thus:

		Inches.	
Temperature of the vapour at Dumdum	72° =	0.770	pressure.
Temperature of the vapour at the Nítee Ghaut	41° =	0.273	pressure.
Difference		0.497	

To be deducted from the height of the barometer at the latter station: which is equal to 447 feet deducted from the altitude of the pass—

16,814 height.
— 447

16,367 corrected height.

This is as near as it is possible to come, without actual observations with the hygrometer, and the correction decreases considerably the amount of the anomaly complained of in the measurement of those lofty mountains.

METEOROLOGICAL JOURNAL.

Date. 1820.	Hour.	Moon's Age.	Pressure. Of the whole Atmosphere.	Pressure. Continuous rise and fall of Barometer.	Pressure. Of the Vapour.	Temperature. Of the Air.	Temperature. Of the Vapour.	Temperature. Difference.	Weight in grs. of Vapour in the space of a cubic foot. As expanded by the existing temperature.	Weight in grs. of Vapour. Maximum at the temperature of the Vapour.	Weight in grs. of Vapour. Maximum at the temperature of the Air.	Temperature. Highest.	Temperature. Lowest.	Temperature. Of a good radiator on the ground.	Quantity of rain.	De Luc's Hygrometer. Dry.	De Luc's Hygrometer. Moist.	Force of evaporation in grs. from a surface 6 ins. diameter.	Wind. Direction.	Wind. Force.	Prevailing Clouds.	Observations.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Nov. 27	9		29.83		0.229	36	36		2.629								25		NW	brisk	mist and stratus	Overcast and damp—sun like a ball.
	4		29.83		0.229	37	36	1	2.621	2.629	2.717	37						0.04	NWN	ditto	ditto ditto	Very misty and damp.
	10		29.83	+0.19	0.180	29	29		2.096				29	27			25			calm	fog	Very foggy—immense deposition of frozen moisture.
28	9		29.79		0.193	31	31		2.240						0.57		25			ditto	ditto	Ditto ditto.
	4	○	29.72		0.207	33	33		2.393											ditto	ditto	Very foggy and damp.
	10		29.66		0.273	41	41		3.106			41	33	31			24		SW	little	overcast	Hard steady rain.
29	9		29.61		0.363	49	49		4.058								20			ditto	stratus and fog	Very close and damp.
	4		29.60	−0.23	0.375	50	50		4.195			51			0.15					ditto	ditto ditto	Rain and fog—every thing covered with moisture.
	11		29.66	+0.06	0.375	50	50		4.195				48	45			21		S	brisk	ditto ditto	Ditto—ditto.
30	9		29.64		0.388	51	51		4.330								20			ditto	ditto ditto and scud	Ditto—ditto, and small rain.
	3		29.58		0.388	51	51		4.330			51			0.12					ditto	ditto ditto ditto	Rain.
	10		29.53	−0.13	0.339	47	47		3.815				46	43			25			ditto	ditto ditto and lighter	Clouds higher—moon visible.
Dec. 1	9		29.72		0.339	48	47	1	3.804	3.815	3.940						16	0.04	NW	little	ditto ditto	Overcast—clouds breaking.
	4		29.91		0.294	46	43	3	3.307	3.326	3.699	48						0.13		ditto	cirro-cumuli & cumulo-strati	Cleared at one o'clock—sun shone.
	10		29.97	+0.44	0.237	37	37		2.717				36	28			18			ditto	cirri and mist	Moon and stars dim—great deposition of moisture.
2	9		29.91		0.351	48	48		3.940								18		SW	high	stratus and scud	Very damp—rain in the night.
	4		28.89	−0.08	0.339	47	47		3.815			48								brisk	ditto ditto and fog	Rain all day—close and damp.
	11		30.00		0.215	38	38		2.803				30	25			15			little	mist	Moon and stars bright—great precipitation.
3	10		30.08	+0.19	0.207	35	33	2	2.383	2.393	2.545						19	0.07	NNW	ditto	light stratus	Morning very fine—great precipitation.
	4		30.07	−0.01	0.254	39	39		2.900			39							SWW	ditto	cirri and mist	Foggy but fine—very damp.
	10		30.09	+0.02	0.254	39	39		2.900				34	29			16			ditto		Moon and stars bright—great precipitation.
4	10	☾	29.63		0.328	49	46	3	3.675	3.699	4.068	49					21	0.18	SW	brisk	stratus and scud	Much rain in the night—cleared up at ten.
	4		29.50	−0.59	0.305	44	44		3.452						0.13					ditto	stratus	Fine till two—heavy rain.
	10		29.52		0.283	42	42		3.214				39	39			20			stormy	overcast	Hard rain.
5	10		29.73		0.245	41	38	3	2.787	2.803	3.106						10	0.17	E	high	stratus and scud	Dark and windy.
	4		29.74		0.254	40	39	1	2.895	2.900	2.999	41			0.11			0.06		ditto	ditto ditto	Ditto ditto—bleak and cold.
	10		29.89		0.221	35	35		2.545				35	33			11			stormy	overcast	Ditto ditto ditto.
6	10		29.97		0.237	37	37		2.717								13		NE	high	stratus and scud	Dark, windy, and cold.
	4		29.97		0.229	36	36		2.629			37								ditto	ditto ditto	Ditto ditto ditto.
	10		29.98	+0.48	0.207	35	33	2	2.384	2.393	2.545		33	31	0.07		17	0.09		ditto	ditto ditto	Ditto ditto small rain.
7	9		29.95		0.207	33	33		2.393								19			ditto	ditto ditto	Ditto ditto and sleet.
	4		29.90		0.207	33	33		2.393			34			0.10					ditto	ditto ditto	Ditto ditto and small rain.
	11		29.90	−0.05	0.214	34	34		2.438				29	29			16			ditto	ditto ditto	Ditto ditto.
8	9		29.94		0.139	29	22	7	1.619	1.642	2.096						20	0.25	E	stormy	cumulo-strati	Clouds breaking—intensely cold—stormy.
	4		29.96		0.120	28	18	10	1.397	1.428	2.030	29						0.31		ditto	ditto few	Very fine—intensely cold.
	11		29.97		0.120	21	18	3	1.420	1.428	1.506		20	13			21	0.04		calm	none	Moon and stars very clear.
9	10		29.98	+0.18	0.144	24	23	1	1.694	1.698	1.763						13	0.02	NE	little	stratus and cumulo-stratus	Clouding over.
	4		29.96		0.150	29	24	5	1.745	1.763	2.096	29						0.19		high	do.do. scud&high cirro-cumuli	Cloudy and cold.

METEOROLOGICAL JOURNAL—*continued.*

Date. 1819.	Hour.	Moon's Age.	Pressure. Of the whole Atmosphere.	Pressure. Continuous rise and fall of Barometer.	Pressure. Of the Vapour.	Temperature. Of the Air.	Temperature. Of the Vapour.	Temperature. Difference.	Weight in grs. of Vapour in the space of a cubic foot. As expanded by the existing temperature.	Maximum at the temperature of the Vapour.	Maximum at the temperature of the Air.	Temperature. Highest.	Lowest.	Of a good radiator on the ground.	Quantity of rain.	De Luc's Hygrometer. Dry.	Moist.	Force in grs. of evaporation, from a surface 6 ins. diameter.	Wind. Direction.	Wind. Force.	Prevailing Clouds.	Observations.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		18	19	20	21	22
	10		29.90	....	0.168	27	27	..	1.959	....	....	..	27	26	0.21	..	15	....	....	stormy	overcast	Hard fall of snow.
Dec. 10	10		29.83	— 0.15	0.180	30	29	1	2.092	2.096	2.162	..	..	....	0.20	..	16	0.02	N	brisk	cumulo strati	Overcast and dull.
	4		29.88	....	0.180	30	29	1	2.092	2.096	2.162	32	..	....	....	..	..	0.02	....	little	ditto	Ditto ditto.
	10		29.93	+ 0.10	0.134	21	21	..	1.586	....	....	..	17	12	....	..	16	....	....	calm	mist	Fine—stars dim—hoar-frost.
11	9		29.92	— 0.01	0.108	18	15	3	1.285	1.292	1.428	..	..	....	....	..	12	0.06	NW	ditto	ditto	Very fine—intensely cold.
	4		29.93	....	0.134	23	21	2	1.580	1.586	1.698	24	..	....	....	..	..	0.01	....	little	ditto	Ditto foggy.
	10		29.94	+ 0.02	0.134	23	21	2	1.580	1.586	1.698	..	20	13	....	..	16	0.04	....	ditto	none	Very fine.
12	10	●	29.89	....	0.186	32	30	2	2.151	2.162	2.317	..	..	....	....	..	10	0.06	W	ditto	haze	Very fine.
	3		29.83	....	0.207	33	33	..	2.393	....	....	34	..	....	0.17	..	..	....	....	ditto	stratus	Sleet—rain—fog.
	11		29.78	....	0.193	31	31	..	2.240	....	....	..	21	15	....	..	9	....	....	ditto	overcast	Stars dim—a little snow.
13	9		29.72	....	0.156	26	25	1	1.828	1.831	1.897	..	..	....	....	..	10	0.03	NW	ditto	mist	Morning perfectly fine.
	3		29.70	....	0.193	31	31	..	2.240	....	....	32	..	....	....	..	..	....	W	ditto	stratus and cirri	Very fine—misty.
	11		29.70	....	0.168	27	27	..	1.959	....	....	..	22	15	....	..	8	....	....	ditto	mist	Ditto—stars dim.
14	9		29.66	....	0.156	25	25	..	1.831	....	....	..	..	....	....	..	13	....	W	ditto	cirro-cumuli and fog	Fine—hoar frost.
	5		29.54	....	0.207	33	33	..	2.393	....	....	33	..	....	....	..	..	....	SW	ditto	fog	Fine, but misty—fog—hard rain.
	11		29.49	....	0.186	30	30	..	2.162	....	....	..	28	22	....	..	10	....	....	ditto	none	Fine and frosty.
15	9		29.45	....	0.200	32	32	..	2.317	....	....	..	..	....	....	..	11	....	W	brisk	cumulo-stratus and scud	Fine—clouded over.
	4		29.42	— 0.52	0.214	35	34	1	2.433	2.438	2.545	35	..	....	0.03	..	..	0.03	....	ditto	ditto and stratus	Some rain.
	11		29.55	....	0.207	33	33	..	2.393	....	....	..	29	25	....	..	12	....	....	little	none	Very fine.
16	9		29.79	....	0.193	31	31	..	2.240	....	....	..	..	....	....	..	15	....	W	brisk	scud and mist	Fine, but misty.
	3		29.89	....	0.214	34	34	..	2.438	....	....	35	..	....	....	..	..	....	....	ditto	ditto ditto	Ditto.
	11		29.91	+ 0.50	0.207	33	33	..	2.393	....	....	..	30	21	....	..	17	....	....	little	overcast	Very dull—rain.
17	9		29.66	....	0.237	37	37	..	2.717	....	....	..	..	....	....	..	20	....	S	brisk	stratus	Small steady rain.
	4		29.38	....	0.305	44	41	..	3.452	....	....	44	..	....	....	..	..	....	....	ditto	ditto	Hard incessant rain.
	11		29.37	....	0.375	50	50	..	4.195	....	....	..	43	40	....	..	23	....	....	little	overcast	Light rain—very close.
18	9		29.35	— 0.56	0.388	51	51	.	4.330	....	....	..	..	....	....	..	25	....	SW	brisk	stratus and scud	Close and dull—damp running down every thing.
	4		29.48	....	0.401	52	52	..	4.468	....	....	53	..	....	....	..	..	....	....	little	ditto ditto	Steady small rain.
	11		29.62	....	0.363	50	49	1	4.061	4.068	4.195	..	48	44	....	..	20	....	....	ditto	ditto ditto	Clouds breaking—stars at intervals.
19	10		29.77	+ 0.42	0.388	51	51	..	4.330	....	....	..	..	....	0.09	..	21	....	SW	little	stratus, scud and mist	Overcast, and very damp—some rain.
	4		29.76	....	0.415	53	53	..	4.616	....	....	53	..	....	....	..	..	....	....	ditto	ditto ditto ditto	Ditto ditto—hard rain.
	11		29.69	....	0.415	53	53	..	4.616	....	....	..	51	50	....	..	20	....	....	ditto	ditto ditto ditto	Ditto—very close—rain.
20	10	☽	29.62	....	0.415	53	53	..	4.616	....	....	..	..	....	....	..	28	....	....	brisk	ditto ditto ditto	Oppressive—close—rain.
	4		29.60	— 0.17	0.401	52	52	..	4.468	....	....	53	..	....	0.07	..	..	....	....	ditto	ditto ditto and high cirri	Ditto—hard rain.
	11		29.66	....	0.401	52	52	..	4.468	....	....	..	44	42	....	..	18	....	....	high	overcast	Close and damp—rain.
21	9		29.86	+ 0.26	0.273	46	41	5	3.078	3.106	3.699	..	..	....	....	..	13	0.28	N	brisk	cumulo-stratus	Morning grey, but dry.
	4		29.78	....	0.283	42	42	..	3.214	....	....	..	42	....	....	..	..	....	SE	ditto	stratus	Sudden change of wind—rain.
	11		29.66	....	0.388	51	51	..	4.330	....	....	51	..	41	....	..	16	....	....	little	overcast	Much rain—oppressive.

	11		[illegible]	....	[illegible]	[illegible]	[illegible]	..	[illegible]	....	....	..	44	44	....	..	20	....	....	little	overcast	Hard steady rain—stormy.
23	10		29.26	....	0.253	42	42	..	3.214	....	....	..	..	....	....	..	15	....	NW	brisk	stratus and scud	Hard rain—clearing.
	3		29.20	— 0.40	0.221	40	35	5	2.519	2.545	2.999	42	..	....	....	..	..	0.21	....	ditto	cirri and scud	Fine—sun broke through.
	11		29.21	....	0.229	36	36	..	2.629	....	....	..	30	21	....	..	10	....	....	little	cirro-cumuli	Night fine—stars dull.
24	9		29.30	+ 0.04	0.200	32	32	..	2.317	....	....	..	..	....	....	..	7	....	....	brisk	scud and mist	Hoar frost—fine, but misty.
	3		29.26	....	0.207	33	33	..	2.393	....	....	33	..	....	....	..	..	....	SE	ditto	thick fog	Fine—very foggy.
	11		29.26	— 0.04	0.193	31	31	..	2.240	....	....	..	26	19	....	..	5	....	....	ditto	mist	Moon and stars bright.
25	10		29.31	....	0.191	32	31	1	2.235	2.240	2.317	..	..	....	....	..	7	0.03	N	ditto	stratus and scud	Hoar frost—dull—some snow.
	4		29.33	....	0.168	31	27	4	1.914	1.959	2.240	32	..	....	....	..	..	0.13	NE	ditto	none	Fine and fresh.
	11		29.39	....	0.156	29	25	4	1.817	1.831	2.096	..	24	16	....	..	6	0.13	....	ditto	none	Moon and stars bright.
26	10		29.42	....	0.156	27	25	2	1.824	1.831	1.959	..	..	....	....	..	7	0.05	NW	little	haze-cirri	Fine, but misty—hoar-frost.
	4		29.43	....	0.168	29	27	2	1.951	1.959	2.096	30	..	....	....	..	..	0.07	....	variable	ditto	Day very fine.
	10		29.43	+ 0.17	0.186	30	30	..	2.162	....	....	..	29	23	....	..	8	....	....	brisk	cirro-cumuli and haze	Fine—stars and moon dull.
27	10		29.40	....	0.193	31	31	..	2.240	....	....	..	..	....	....	..	9	....	SE	ditto	mist	Fine—hoar frost.
	3		29.40	— 0.03	0.180	31	29	2	2.089	2.096	2.240	32	..	....	....	..	..	0.06	....	ditto	cirri and haze	Day fine—hazy.
	11		29.42	....	0.180	30	29	1	2.092	2.096	2.162	..	28	25	....	..	8	0.04	....	high	ditto	Moon obscured with light clouds.
28	10		29.43	....	0.214	34	34	..	2.438	....	....	..	..	....	....	..	10	....	E	brisk	stratus and scud	Very dull—hoar-frost.
	4		29.43	....	0.200	33	32	..	2.317	....	....	34	..	....	....	..	..	....	....	ditto	ditto	Hard fall of snow.
	11		29.46	....	0.186	31	30	1	2.158	2.162	2.240	..	25	15	....	..	11	0.04	....	ditto	cumulo-stratus	Overcast.
29	10		29.55	....	0.168	27	27	..	1.959	....	....	..	..	....	....	..	10	....	SW	ditto	scud	Fine—scud low—misty.
	3		29.57	+ 0.14	0.180	29	29	..	2.096	....	....	29	..	....	....	..	..	....	....	ditto	ditto	Fine, but hazy.
	11		29.54	....	0.144	23	23	..	1.698	....	....	..	21	14	....	..	9	....	....	ditto	ditto	Ditto.
30	10		29.48	....	0.156	25	25	..	1.831	....	....	..	..	....	....	..	10	....	W	little	stratus and fog	Very foggy.
	3		29.43	....	0.193	31	31	..	2.240	....	....	..	..	....	....	..	..	....	,WS	ditto	ditto ditto	Fine but foggy.
	11		29.37	....	0.200	32	32	..	2.317	....	m..	32	25	19	....	..	9	....	....	ditto	overcast but light	Night overcast with light clouds.
31	10		29.32	....	0.150	27	24	3	1.753	1.763	1.959	.	..	....	....	..	10	0.07	SW	ditto	cirri and hazy	Fine but hazy.
	3		29.31	....	0.162	30	26	4	1.883	1 897	2.162	30	..	....	....	..	..	0.09	....	ditto	light haze	Day cloudless.
1820	12	○	29.30	— 0.27	0.134	21	21	..	1.586	....	....	..	17	15	....	..	10	....	....	ditto	ditto	Beautiful night.
Jan. 1	10		29.38	....	0.124	20	19	1	1.471	1.474	1.529	..	..	....	....	..	9	0.62	....	ditto	mist	Hoar-frost—very fine.
	3		29.44	....	0.168	27	27	..	1.959	....	....	27	..	....	....	..	..	....	NW	ditto	dense fog	Sun blood-coloured—houses white.
	11		29.53	....	0.156	25	25	..	1.831	....	....	..	20	12	....	..	10	....	....	calm	ditto	Moon pale, and but just visible.
2	10		29.54	+ 0.24	0.186	30	30	..	2.162	....	....	..	..	....	....	..	13	....	SW	ditto	cirri and mist	Fine—fronts of houses white.
	3		29.50	....	0.221	35	35	..	2.545	....	....	..	..	....	....	..	..	....	....	ditto	stratus and fog	Small rain and very damp.
	10		29.38	— 0.16	0.237	37	37	..	2.717	....	....	37	30	29	....	..	18	....	....	ditto	ditto ditto	Hard rain and fog.
3	10		29.58	....	0.156	30	25	5	1.814	1.831	2.162	..	..	....	....	..	17	0 16	N	brisk	cirro-cumuli	A little snow—fine and clear.
	3		29.76	....	0.156	29	25	4	1.817	1.831	2.096	30	..	....	....	..	..	0.14	NW	ditto	none	Perfectly fine and exhilarating.
	11		29.92	....	0.162	26	26	..	1.897	....	....	..	22	16	....	..	15	....	....	little	haze	Cloudless night.
4	9		29.98	+ 0.61	0.150	24	24	..	1.763	....	....	..	..	....	....	..	13	....	W	ditto	dense fog	Hoar-frost—dense fog—sun red.
	3		29.97	— 0.01	0 150	26	24	2	1.756	1.763	1.897	26	..	....	....	..	..	0.05	NW	brisk	cirro-cumuli	Dense fog—clearer at three.
	11		29.98	....	0.134	21	21	..	1.586	....	....	..	17	14	....	..	12	....	....	little	mist	Night fine but misty.
5	10		30.05	....	0.124	20	19	1	1.471	1.474	1.529	..	..	....	....	..	11	0.02	....	ditto	ditto	Hoar-frost.
	3		30.06	+ 0.09	0.156	25	25	..	1.831	....	....	26	..	....	....	..	..	....	W	ditto	fog	Foggy—sun red.
	11		30.05	....	0.156	25	25	..	1 831	....	....	..	22	16	....	..	13	....	....	ditto	none—mist	Fine.
6	10		30.03	— 0.03	0.168	27	27	..	1.959	....	....	..	..	....	....	..	13	....	NW	ditto	fog	Immense deposition of hoar-frost.
	4		30.04	....	0.214	34	34	..	2 438	....	....	31	..	....	....	..	..	....	....	calm	ditto and stratus	Thaw commencing from the ground.
	12		30.06	....	0.221	35	35	..	2.545	....	....	..	31	31	....	..	20	....	....	high	overcast	Very dark—some rain.
7	10		30.18	....	0.144	32	23	9	1.666	1.698	2.317	32	..	....	....	..	15	0.35	SE	ditto	stratus	Very dull and windy.
	3		30.28	....	0.134	28	21	7	1.564	1.586	2.030	..	..	....	....	..	..	0.25	E	ditto	ditto ditto and scud	Ditto ditto—cutting cold.
	11		30.35	....	0.129	26	20	6	1.510	1.529	1.897	..	21	21	....	..	12	0.20	....	ditto	overcast	Dark—cold.
8	10		30.42	....	0.139	27	22	5	1.625	1.642	1.959	27	..	....	....	..	10	0.17	NE	ditto	stratus in the horizon	Perfectly fine and clear—sharp.
	3	☾	30 44	....	0.134	26	21	5	1.570	1.586	1.897	..	..	....	....	..	..	0.17	....	ditto	ditto and scud	Fine, but more clouds.
	11		30.52	....	0.124	23	19	4	1.030	1.039	1.698	..	21	18	....	..	11	0.12	....	stormy	overcast	Dull.
9	10		30.59	+ 0.56	0.156	26	25	1	1.828	1.831	1.897	..	..	....	....	..	11	0.05	....	high	cirro-cumuli and scud	Slight snow showers.
	4		30.51	....	0.144	26	23	3	1.687	1.698	1.897	..	..	....	....	..	..	0.11	....	ditto	ditto and cirri	Very fine.
	11		30.32	....	0.174	28	28	..	2.030	....	....	28	21	19	....	..	13	....	....	stormy	overcast	Snow.
10	10		30.31	....	0.150	25	24	1	1.759	1.763	1.831	..	..	....	....	..	11	0.02	NE	brisk	cumulo-stratus	Morning fine.
	3		30.24	....	0.162	26	26	..	1.897	....	....	27	..	....	....	..	..	....	....	ditto	stratus	Snow showers.
	11		30.11	....	0 162	26	26	..	1.897	....	....	..	25	25	....	..	13	....	....	little	overcast	Ditto—dark—much snow.
11	10		29.90	....	0.174	28	28	..	2.030	....	....	..	..	....	....	..	14	....	SW	ditto	stratus and fog	Much snow—rain.
	4		29.70	....	0.200	32	32	..	2.317	....	....	..	..	....	....	..	..	....	....	ditto	ditto ditto	Heavy fall of snow.
	11		29.67	— 0.92	0.200	33	33	..	2.303	....	....	33	25	25	....	..	17	....	....	brisk	overcast	Dark and damp.

N. B. In consequence of a mistake, the remainder of this Quarter's observations is postponed till the next Number.

Art. XII. *Exhumation and Re-interment of* Robert Bruce.

To the Editor of "The Journal of Science and the Arts."

Dear Sir,

The enclosed extract of a private letter, which I received a few days ago from Edinburgh, may, I think, prove acceptable to two classes of your readers: first, to the lovers of antiquarian research, (and *Ivanhoe* will make us all antiquaries); and, secondly, to the natives of "the land of brown heath," who imbibe with their earliest breath an enthusiasm for the name of *Bruce*, of which, in these latitudes, we cannot be expected to form any adequate idea. It may add to the interest with which it is read, to be told, that it is from the pen of the Professor of the Practice of Physic in the University of Edinburgh.

Believe me, my dear Sir, very faithfully your's,

G.

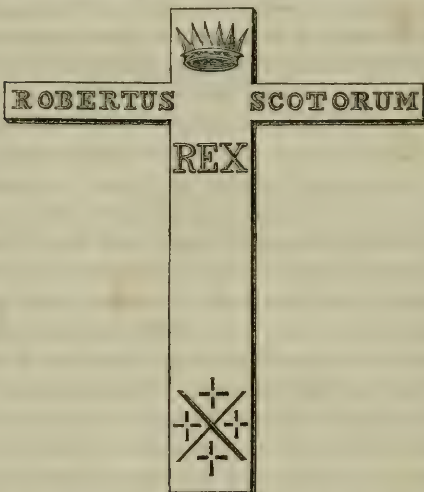
London, March 1, 1820.

Edinburgh, Thursday, Feb. 10, 1820.

I had lately in my hands (Nov. 5, 1819) the scull of a great king, and a great hero, *Roberti Brussii Scotorum Regis, immortalis memoriæ.* If you met with a Scotch newspaper soon after that time, you would know that I had been at his resurrection and re-interment. His grave was *paved* and *lined*, both sides, and head and foot, with *hewn squared* stones; and was covered with three large square stones, each having a large iron ring in it. It was necessary to take down and remove all that mason-work in order to enlarge the grave, so that it might receive the huge new leaden coffin, in which his remains—*bonus, bona, bonum*—for nothing else remained of him, were put. For that purpose, and to give room to the workmen who were to build up a new grave for him of brick, the walls of which are made nine inches thick, with an arch of the same thickness over it, a deep trench, full three feet wide was dug all round the original stone grave. Into that trench I descended. and having got hold of his scull, held it up to the view of the spectators, (who were very numerous), telling them, "This is the head of King Robert." His scull was, 490 years after his death, as entire as yours or mine are at present. So were al-

most all the bones, especially the larger ones: but even the *os hyoides* was entire, so were *some* of the cartilages of the larynx, which had been *ossified*. But all the other cartilages of his body, as well as the ligaments, tendons, and all the softer parts, were completely mouldered into dust. Even the intervertebral cartilages were gone; so that I easily lifted some of the vertebræ and the left humerus, without moving the neighbouring bones. The femur too was lifted as easily. It was carefully measured, and found to be 17½ inches long; supposing it to have been the fourth part of his whole length (the common proportion in a well-made man) his stature must have been 5 feet 10 inches, or at the utmost, 5 feet 11 inches, making allowance for the want of cartilage at both ends of it. His scull too was of the common size, very well formed, with no peculiarity that I could see, except very long styloid processes, by far the largest that I remember ever to have seen. There was not a vestige of encephalon, as I found on putting my middle finger in at the foramen magnum, and turning it round. We found that the sternum had been *sawed* asunder longitudinally from end to end. This, no doubt, had been done immediately after his death, according to his own desire, that his heart should be taken out, and carefully embalmed, and sent to Jerusalem to be buried in the Holy Sepulchre. I presume his whole body had been embalmed. A leaden urn, or rather a square leaden box, supposed to have contained his bowels, as it was full of a *tallowy*, or spermaceti-like matter, was found very near his grave. Some of it was brought away, and given to Dr. Hope, that he might examine it. The King's body had been enclosed in *two coverings* of thin sheet lead, enwrapping it like a double coat of mail; had been covered with a robe, or shroud, of cloth of gold; that is of *linen*, with gold threads in it. That it was *linen, not silk*, I ascertained by burning a small bit of it at the flame of a taper, and smelling to it while burning; it had the smell of linen (or at least of vegetable matter), not the least of the fetor of silk, feathers, or any animal substance. The body had not been put in a leaden coffin, but in a strong oaken one; secured by several strong iron nails, some of which, with a

little of the oak timber, preserved I suppose, by the oxide or carbonate of the iron, sticking to them, I have seen ; and I have eard of one piece of it being found, as big as a man's hand. But almost all the coffin, as well as all the softer parts of his body, were mouldered down to a kind of black dust, which covered the bottom of his grave. In that dust was found a plate of copper, somewhat corroded at the edges, with small holes at the corners, through which it had been nailed on the lid of the coffin. On the copper-plate was engraved a cross, and on the cross, at the top a crown, and at the bottom, his *badge*, the



same as on the reverse of his coins ; and on the two principal bars of it the inscription which you see above ; so the evidence that what we saw was the remains of KING ROBERT THE BRUCE, was complete, even to superfluity. The grave, too, was found accidentally, in the very spot, where, as *Fordun*, one of our oldest Scotch chronicle writers, mentions, he had been buried;—*in medio chori*. But the good presbyterians of Dumfermline had forgotten what a choir was, as completely as Sir John Falstaff had done what the inside of a church is made of; and long ago wishing to find King Robert's grave, and to see what was

in it, had been *howking, (digging*, in old English *houghing)* very diligently, all over the body, or nave, of the church. They might as well have been *howking* in Westminster Abbey.

If his sublime highness Prince Posterity shall wish, *some thousand years* hence, to see the remains of king Robert Bruce, he will find them as entire as I saw them on the 5th of November last. I have taken effectual care of that matter. I suggested to the Barons of the Exchequer, (in Scotland,) who took charge of the business, that it would be desirable to preserve his remains from further decay; and for that purpose, as a cheap, but withal an *excellent*, substance for embalming, by excluding air and water, and resisting putrefaction, I recommended *pitch*; and advised that all vacuities in his grand new leaden coffin should be filled up, by pouring melted pitch into it. This was done: five barrels of pitch, about 1,500lbs., being employed for that purpose. The new leaden coffin is very large, almost seven feet long, two feet eight inches broad at the shoulders, and two feet four inches deep. In it lies His Majesty, fairly embedded in pitch, which, by this time, must be as hard as a stone, and (bating only the chance of being softened a little, or perhaps melted, by the heat of the general conflagration,) must remain so for 10,000, or 20,000 years. So if Prince Posterity shall insist upon seeing the remains of King Robert, he will find it very hard work to pick him out of his shell; and, in the mean time, I have taken care that the present generation shall neither *steal* his bones, (which there was evidently a strong desire to do,) nor toss them about and make a common shew of them, as, within my memory, was done, in a most indecent manner, with the bones of our Kings and Queens who had been buried in the royal vault in the chapel of Holyrood-house. That kind of misdemeanor, as well as the further decay of his remains, I wished to prevent by embalming or enclosing them in pitch. But before that could be done, so alert and zealous were the good people of Dumfermline, that two or three of his teeth, which were very entire, but so loose that they came out in taking a cast (in plaster of Paris,) of his skull, and one, or perhaps more, of his smaller bones, were *stolen*.

I took ——— over to Dumfermline, to assist me at the resurrection. On our return, at the inn at the Queensferry, he convinced me that he had not returned empty-handed, by producing a metatarsal-bone of King Robert, very little decayed. This he declares that *he did not steal;* but he must have received it knowing it to be stolen. However, as it was impossible, by that time to restore it to its rightful owner, it remains with ——— till King Robert shall claim it; and in the mean time I have put it carefully in a glass phial, with a ground-glass stopper, and an explicit memorandum telling whose bone it is, and when it was stolen.

Dr. Monro, who was also at the resurrection, brought with him an excellent artist, (sculptor,) Mr. Scoular, to take *casts* of the king's *head*, and of his face too if it had remained. Mr. Scoular is a kind of pupil and assistant to Mr. Chantry, whose fame and merit are well known.

Art. XIII. *Reports of the Commissioners appointed for inquiring into the mode of preventing the Forgery of Bank Notes.*

To His Royal Highness George Prince of Wales, Regent of the United Kingdom of Great Britain and Ireland.

In obedience to the directions contained in His Majesty's Commission, we proceeded, in the latter end of the month of July last, to consider the important subject referred to us.

Our attention was first directed to the proposals for improvement in the form of the notes issued by the Bank of England; and it being known that many plans had been submitted to that body, which they had not thought it expedient to adopt, we felt it proper, in the first instance, to obtain correct information upon this point; and we therefore requested the Court of Directors to furnish us with an account of such plans. They did accordingly furnish us, without delay, with a detailed account of *one hundred and eight* projects, regularly classed and arranged; together with the correspondence respecting them, a statement of the trials to which they had been subjected, and specimens of the proposed originals, and of the imitations executed by order of the Bank. They also laid before us about *seventy* varieties of paper made at their manufactory in experiments for its improvement, in which almost every alteration recommended for adoption had been tried, and, in some instances, anticipated by their own manufacturer.

We have also received and answered communications from about seventy

individuals, which have been arranged and considered; and, in some cases, a personal interview has been requested, and held. Several of these persons had been previously in communication with the Bank; and we find that in the instance of some projects of superior promise, the Directors had furnished to the proposers, the pecuniary means of carrying their ideas into effect. We have likewise sought and obtained information, as to the state of the paper currency in other countries; but this has proved of very little importance, with reference to the object of our present inquiry. From America, which affords the closest parallel to the state of England in this particular, no official return has yet been received, but we have reason to think, that in several parts of the United States, the crime of forgery is prevalent, and that great efforts are now making to give to the notes such a character as may baffle the skill of the American forger. Specimens of these improved notes have been communicated to us by the agent of the American patentee, and have received our particular attention with regard to the practicability of adopting the invention, in whole or in part, so as to present a barrier to the art and skill of the forger in this country.

Upon the general subject of the extent of forgery, we do not think it necessary to recapitulate statements which are already before Parliament and the public. It appeared to us, however, proper to obtain more particular information as to the course which has been hitherto pursued by the Bank, both with respect to the prevention, and with respect to the detection and punishment of the crime. Upon the former of these points, we have received from the Directors, in addition to the account before alluded to, clear and circumstantial details. And it is but common justice to those gentlemen to state, that in every instance our inquiries have been met by them in the most prompt and satisfactory manner, and every sort of useful information readily furnished. We feel it also proper to add our opinion, formed after an examination of all the projects which have been formerly submitted to the Bank for a change in the form of their notes, that no one of these could have been adopted with such a prospect of solid advantage to the public, as would compensate the evils necessarily attendant upon a change.

The invention to which we refer in the latter part of this Report, and on which our attention is now principally engaged, was laid before the Directors a short time previous to the issuing of His Majesty's Commission, and so far entertained by them, that they advanced a large sum of money to the author. The chief merit of this invention consisting in the extreme accuracy of the machinery requisite, time and application are necessary to bring it to such a state of perfection as appears likely to answer the purpose desired.

Upon the latter of the two points above referred to, we have received from the Chief Inspector and Chief Investigator at the Bank, and also from the Solicitor, accounts of the course pursued in their respective departments. For which purpose, we requested the personal attendance of each of those officers, and entered into such an examination of them, as appeared to us to be calculated to produce the necessary information. We

have also been furnished by the Bank with the means of judging of the actual state of forgery, and of that degree of skill which appears sufficient to deceive the public, by the examination of forged notes of various kinds; and even of the tools and instruments used by one forger, which were taken upon him.

Whilst it is painful to observe the degree of talent thus perverted, it is at the same time to be remarked, that in many instances the public suffer themselves to be deceived by very miserable imitations; and it is to be feared that a similar carelessness would very much lessen the good effects to be derived from the employment of superior skill and workmanship in the formation of a new note. Another fact appears proper to be noticed here, as forming an important ingredient in the consideration of any proposed plan. The issue of small notes by the Bank is necessarily very uncertain and irregular in its amount. We find, that to keep up the usual supply, no less than fifty plates are requisite; and it is considered proper to have a much larger number in a state of preparation. And as it is obviously necessary to preserve, as much as possible, identity in the notes, this circumstance alone precludes the application for this purpose of many ingenious plans, even if there did not exist other insuperable objections to them.

Resulting from the above statements and examinations, some general observations have occurred to us, which appear proper to be introduced in this stage of the Report.

It has been very commonly imagined, that, in consequence of the simplicity of execution in the present Bank notes, the actual forgery of them was very generally and extensively practised, and that often by persons without money or talent; and this idea has formed the basis of much of the reasoning used by many of the projectors, whose plans have been under our view. The reverse of this we believe to be the fact; and from the information before us, we feel ourselves warranted in stating our opinion, that the great quantity of forged small notes which have lately been found in circulation, have all issued from a very few plates only; and that the fabrication of them is chiefly confined to one particular part of the country, and carried on by men of skill and experience, and possessed of a very considerable command of capital. Upon a cursory observation, it appeared remarkable that whilst so many utterers are constantly brought to justice, the actual forger should very rarely indeed be detected. But further investigation has led us to think, that this fact may be accounted for; and without entering into details, which upon this point it is better to avoid, we think that it results naturally from the lamentable perfection of system, to which this fraudulent traffic has been brought; and we have seen no reason to doubt that the directors of the bank, and their officers, have used every exertion in their power to bring the actual forgers to justice, though unfortunately without success, except in very few instances. We cannot refrain however from adding to this statement, our opinion, that there must be some culpable remissness in the local police of those districts within which the actual fabricators of bank notes are more than suspected to reside, and to carry on their trade with impunity. And before we quit this

part of the subject, we wish to suggest, for the consideration of those by whose judgment such a question may be properly decided, whether it might not be expedient to offer a very large reward for the apprehension and conviction of a person *actually engaged in forging* bank notes. We are aware of the objections which exist against the system of pecuniary rewards, and are fully impressed with a sense of the evils that may arise from a too general adoption of it. But the circumstances under which the crime of forgery exists in this country are peculiar; and it appears to us hardly possible that those evils, which might be anticipated from the offer of a reward in the case of some other crimes, could follow from such an offer in this case; and knowing how many individuals must be saved from punishment by the conviction of one actual forger, we venture to recommend the adoption of this measure, to be concurrent with such an improvement in the form of the note as we hope to see effected.

Having been furnished with such information as was within our reach, relative to the subject of our inquiry, we, in the next place, proceeded to examine more in detail the several projects submitted to us. In pursuing this examination, we have not indulged the vain expectation of finding any plan for a bank note, which shall not be imitable by the skill of English artists, and we have considered that it would be utterly unsafe to rely for security against forgery, upon the employment of any process, the chief merit of which was to consist in its being kept secret; of which several have been communicated to us. Our object has been, to select some plan, of which the process, when the principles of it are understood, and the machinery and implements provided, should be simple enough to be applied without interruption to the extended operations of the Bank; and should at the same time comprise so much of superior art, as may oppose the greatest possible difficulties to the attempts of the forger, and may present such points of accuracy and excellence in workmanship to the eye of any individual using ordinary caution, as shall enable him to detect a fraud by observing the absence of those points in a fabricated note. In the mass of the schemes before us, there are, of course, very various degrees of merit; and we endeavoured to class them as well as circumstances would permit. From a very large portion of them it was obvious, upon a first inspection, that no beneficial result could be expected. Of the whole number, we find about twelve of superior skill and ingenuity, but anticipated by others of higher merit; or merely ingenious, but inapplicable in practice. And we consider nine others to be either of such originality or ingenious combination of existing means, as to have required our more particular attention; and with respect to these, much consideration has been had, and, in some instances, improvements and experiments suggested and tried.

We have not considered, as decisive against the merit of any particular plan, the single fact, that it may be imitated by superior art and expensive means. But when we have found, in the case of specimens submitted to us, apparently of great excellence, and the result of a combination of talent or machinery, that a very good imitation has been produced in a *short time*,

without any *peculiar expense*, and by the *application of means only*, which are within the reach of very many artists and engravers in England; and when we reflect, to how very few hands the business of forgery appears to be at present confined, we cannot doubt that in the event of bank notes being formed from any of such specimens, an equal number at least of persons would very soon indeed be found capable of fabricating those notes to a considerable extent, and with a degree of skill quite sufficient to deceive the public. Another consideration has also had weight in inducing us to hesitate much, before we venture to recommend any specific plan. The adoption of any new form of note presenting peculiar and characteristic marks, but the imitation of which we could not confidently feel to be extremely difficult, would not only not do good, but would produce much evil; and would induce a false security, by accustoming the public to rely upon the appearance of such marks and peculiar character, rather than upon a cautious and general observation of the whole note.

Our remarks however, as to imitation, do not apply to all the specimens which have been offered to us. There are a few of singular and superior merit, produced by means which it is very improbable should ever come within the reach of any single forger, and the imitation of which, except by those means, appears in a high degree difficult.

Safety, or rather comparative safety, is to be sought, to a certain extent, in a combination of excellence in various particulars; but chiefly, as we conceive, in the application of a principle beyond the reach of the art of the copper-plate engraver, which in its different processes is possessed of the most formidable power of imitation. One plan, before alluded to, as apparently affording this advantage, has been, with the most liberal assistance from the Bank, for some time past in a course of trial for its greater perfection, and with a view to combination with other improvements, satisfactory experiments of which have already been effected. The result, if our expectations be not disappointed, will afford a specimen of great ingenuity in the fabric of the paper, of great excellence in the workmanship, and of a very peculiar invention, and difficult machinery in the art of printing. We confidently hope, that no long time will elapse, before we are enabled to lay before your Royal Highness that result; and we have every reason to know, that the Bank Directors are sincerely anxious to adopt any plan which shall be found, after patient examination, to be worthy of adoption. In the mean time, we have thought it right not to delay informing your Royal Highness of the course of our proceedings. The investigation in which we have been engaged, has strengthened rather than removed our feeling of the difficulties with which the whole subject is surrounded. We do not wish to represent those difficulties as precluding the propriety of an attempt to remove the existing evils, by a change in the form of the notes issued by the Bank of England; but we do feel them to be such, as make it imperative upon those with whom the responsibility rests, to be fully satisfied that they shall produce an improvement, before they venture to effect a change.

All which is humbly submitted to your Royal Highness's consideration and judgment.

Jos. Banks.
William Congreve.
William Courtenay.
Davies Gilbert
Jer. Harman.
Will. H. Wollaston.
Charles Hatchett.

Soho Square, Jan. 15, 1819.

Final Report of the Commissioners appointed for inquiring into the Mode of Preventing the Forgery of Bank-Notes.

To His Majesty George the Fourth, King of the United Kingdom of Great Britain and Ireland.

Since we had the honour of explaining to your Majesty the course of our proceedings, a longer interval has elapsed than we had anticipated as likely to occur. This has arisen partly from our wish to have some experiments tried, with a view to the improvement of that plan, which we then stated ourselves to have selected, and partly from our anxiety to give the fullest and most deliberate consideration to another plan, of great ingenuity, and exhibiting specimens of beautiful work, which had formerly been suggested to us, and the particulars of which have upon several occasions, and within a recent period, been laid before us: this plan, however, after such consideration, we do not find to possess such merit as would make it proper for us to recommend its adoption, in preference to that which we had first selected.

With respect to the paper, we are of opinion that it will not be advisable to make any alteration in that which is now used by the Bank.

Upon the whole, we have ventured to recommend for adoption by the Bank the plan brought forward by Messrs. Applegath and Cowper, which was originally submitted to the Directors a short time only before the appointment of this commission, and received immediate encouragement from them; and upon which some improvements have since been made. The directors have readily complied with this recommendation, and the necessary machines are in a state of great forwardness.

We humbly conceive that your Majesty, for obvious reasons, would not wish us to enter upon any detailed explanation of the particulars of this plan. The objects which we have kept in view, in making the selection upon which we have determined, have been to enable the Bank to ensure to the public a regular supply of their notes in sufficient quantity to meet the daily demand, and to have those notes executed in such a manner, as shall render them fit for general circulation amongst all classes of society; whilst at the same time very considerable obstacles are opposed to the art of any person who might be disposed to engage in forging them. And we

humbly submit to your Majesty our opinion, that these objects will be attained by the adoption of the note formed by the machines submitted to our view by Messrs. Applegath and Cowper.

We cannot but be aware, that no form of a note can possibly be contrived that may not be successfully imitated by some artist of superior talents; we hope, however, and we believe, that no man capable of forging the note which we recommend can be in such distressed circumstances as to feel any inclination to place himself in danger of the ignominious punishment which awaits a crime so hurtful to public credit, and to the community at large.

All which is humbly submitted to your Majesty's consideration and judgment.

Jos. Banks.
Wm. Congreve.
Wm. Courtenay.
Davies Gilbert.
Jer. Harman.
Wm. H. Wollaston.
Charles Hatchett.

Art. XIV. *Proceedings of the Royal Society.*

The following papers have been read at the table of the Royal Society, since our last report:

Jan. 13. An Account of a Case of Ovario-gestation. By A. B. Granville, M.D., F.R.S.

Feb. 17. On some Combinations of Platinum. By Mr. E. Davy.

—— 24. On the Methods of Cutting Rock-crystal for Micrometers. By W. H. Wollaston, M.D., F.R.S.

March 2. On a New Principle of Constructing Ships in the Mercantile Navy. By Sir Robert Seppings, F.R.S.

—— 9. On a Peculiarity in the Structure of the Eye of the Balæna Mysticetus. By Mr. J. A. Ransome.

—— 16. On the Law of the Variation of the Flexibility of Canadian Fir. By M. Charles Dupin.

Art. XV. ASTRONOMICAL AND NAUTICAL COLLECTIONS, No. I.

[The astronomical ephemerides of foreign countries have commonly contained, in addition to the tables for the year, a variety of novelties relating to the mathematical sciences, which are often of great interest to the practical astronomer, and sometimes of great utility to the seaman. The limited bulk of the *Nautical Almanac*, and the arrangement of the department by which it has been conducted, have not admitted a similar extension of the plan of that highly valuable publication; and there seems to be a particular opening, considering the zeal with which astronomy is now pursued in this country, for some periodical communication of a similar nature, through a more private channel. Upon these grounds the editor of this work has made an arrangement, by which a certain portion of its pages will in future be regularly devoted to astronomical and nautical subjects, not excluding the more refined investigations, but more peculiarly seeking such as are capable of being immediately applied to practical astronomy, or to nautical calculations. He hopes in future to be favoured with some articles from the highest possible nautical authorities; and the first of the series is a translation of a memoir of one of the most justly celebrated astronomers and philosophers of the present day, with some supplementary demonstrations, which have been added by the translator.]

i. *An Essay on the easiest and most convenient Method of calculating the Orbit of a Comet from Observations. By* William Olbers, M.D. 8vo. *Weimar*, 1797. *Translated from the German. With Notes.*

Section I. *General Observations.*

§ 1.

To determine the orbit of a comet by means of geocentric observations was considered, even by the great Newton himself, as far from an easy problem; he calls it, indeed, *longe difficillimum;* and he had attempted its solution in various ways, before he discovered the elegant construction which he has laid down in his *Principia.* This construction is, indeed, worthy of the genius of its inventor; it is, however, laborious, and requires a number of conjectural trials. Since the time of Newton, many of the greatest mathematicians have employed themselves in the investigation; and having satisfied themselves of the impossibility of an accurate direct solution, have substi-

tuted for it a variety of more or less perfect approximations. It seems, therefore, to be interesting to examine the problem, with all its difficulties, and to take a view of the methods which have been proposed for its solution, before we proceed to attempt any improvement in them.

§ 2.

In every observation we have to consider two triangles; the one lying between the comet, the sun, and the earth; the other its orthographical projection, on the plane of the ecliptic: one side is common to both, that is, the distance from the earth to the sun; and the observation gives the angles at the earth: but another element is wanting to the complete determination of either triangle.

§ 3.

We may safely consider the small part of the orbit of every comet, which is in the neighbourhood of the sun, as a parabolic curve, having its focus in the centre of the sun, and consequently situated in a plane which passes through the sun. Supposing the situation of the plane to be given, the line of direction found by each observation determines a point in it; and two points, together with the focus, determine the parabola: if three such directions are given, there can be only one inclination of the orbit for any given position of the node, in which the points will be found in a parabola, and for a given inclination only one line of the nodes: and four such observations leave neither the inclination nor the intersection undetermined, even without any regard to the intervening time.

§ 4.

Three observations would be sufficient, if we only assumed that the times are proportional to the spaces described: but the absolute times being also determined by the distances and the chords, we have a superfluity of conditions, since we obtain four equations for three unknown quantities.

§ 5.

We may easily form a general idea of these four equations. The three unknown quantities may be the three distances

of the comet from the earth. Now three points not in a right line determine the position of a plane; consequently, two points and the sun determine a plane which must pass through the third point; whence we derive the first equation. The condition that the three points must be in a parabola, of which the focus is the sun's centre, affords us the second equation; and the comparison of the times with the revolving radii and the chords, give us the two others. In general, for n observations, and n unknown quantities, we have $3n - 5$ equations; $n - 2$ being derived from the condition that the sun must be in the plane of the orbit; $n - 2$ from the properties of the parabola, and $n - 1$ from the relation between the times and the distances and chords.

§ 6.

With so great an abundance of equations, it might naturally be supposed that a few observations would lead us pretty readily to the direct determination of the elements, with geometrical accuracy. But when we consider the equations themselves, we find them so intricate, that the utmost powers of algebra, and the patience of the most indefatigable calculator, might be exhausted on them in vain. The equations may be represented in the most convenient form, by considering the three curtate distances of the comet from the earth, or the projections of the distances on the plane of the ecliptic, as the unknown quantities.

§ 7.

We may denote the quantities relating to the three different observations by as many accents added to the respective letters; and we may make

A', A'', A''', the sun's longitude.

α', α'', α''', the comet's longitude.

β' β'', β''', the comet's latitude.

R', R'', R''', the earth's distance from the sun.

t', the time between the 1*st* and 2*d* observation.

t'', the time between the 2*d* and 3*d*.

$T = t' + t''$, between the 1*st* and 3*d*.: all these being given quantities.

ρ', ρ'', ρ''', the curtate distance of the comet from the earth.

x', x'', x''', the distance of the comet from the sun reduced to the direction of the *vernal* equinox.

y', y'', y''', the distance of the comet from the line of the vernal equinox, reduced to the plane of the ecliptic, reckoned *eastwards.*

z', z'', z''', the distance of the comet *northwards* from the plane of the ecliptic.

r', r'', r''', the distance of the comet from the sun.

k', the chord of the comet's orbit between the 1*st* and 2*d* observation.

k'', between the 1*st* and 3*d*.

It is obvious that

$x = \rho$ cos. α — R cos. A.

$y = \rho$ sin. α — R sin. A.

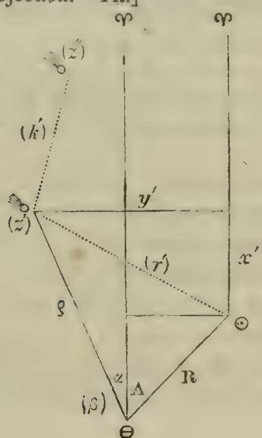
$z = \rho$ tang. β.

$r = \sqrt{(x^2 + y^2 + z^2)}$.

$k' = \sqrt{([x'' - x]^2 + [y'' - y']^2 + [z'' - z']^2)}$.

$k'' = \sqrt{([x''' - x']^2 + [y''' - y']^2 + [z''' - z']^2)}$.

[Note 1. These equations may be more readily understood with the assistance of a figure. The lines not in the plane of the ecliptic are dotted, and the characters relating to them enclosed in parentheses, the line z becoming always a point in an orthographical projection. Tr.]



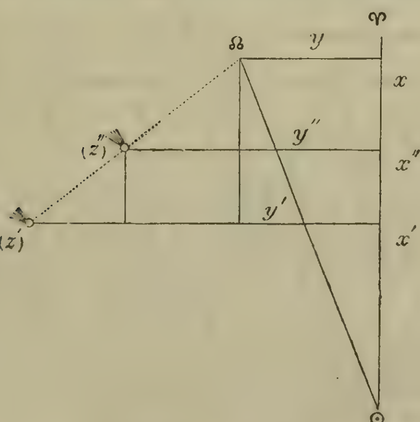
§ 8.

According to this notation, we may easily express the four equations in question. The condition that the three places of the comet must be in a plane, passing through the sun, affords us the equation

$$\frac{y'' z' - y' z''}{x'' y' - x' y''} = \frac{y''' z' - y' z'''}{x''' y' - x' y'''},$$

which is already sufficiently simple, but which may be made considerably more so, when the values of the quantities concerned in it are substituted.

[NOTE 2. The lines joining any successive places of the comet must necessarily pass through the intersection of its orbit with the ecliptic; consequently, the points in which these lines meet the plane of the ecliptic must be situated in the line of the nodes, and the place of the node may be computed from either of them, since the tangent of its longitude will be $\frac{y}{x}$, taking x and y for the ordinates determining its situation in the plane of the ecliptic. For the first pair of observations we



shall obviously have $x = x' + \frac{z'}{z' - z''}(x'' - x')$, and $y = y' - \frac{z'}{z' - z''}(y' - y'')$, which are to each other as $x'(z' - z'') + z'$

$(x''-x') = -x'z'' + z'x''$ to $y'(z'-z'') - z'(y'-y'') = -y'z'' + z'y''$, or as $x'z'' - x''z'$ to $y'z'' - y''z'$; and $\frac{y}{x} = \frac{y'z''-y''z'}{x'z''-x''z'}$ which must also be equal to $\frac{y'z'''-y'''z'}{x'z'''-x'''z'}$, substituting y''' and z''' for y'' and z''; and the fractions will remain equal if we refer the angle to a plane perpendicular to the ecliptic, and employ y', y'', and y''' in the denominators, instead of z', z'', and z'''. Tr.]

The second equation depends on the condition, that the three places of the comet must be in a parabola, of which the sun occupies the focus: hence

$$\frac{-2r' + \sqrt{([r'+r'']^2 - k'^2)}}{\sqrt{(k'^2 - [r''-r']^2)}} = \frac{-2r' + \sqrt{([r'+r''']^2 - k''^2)}}{\sqrt{(k''^2 - (r'''-r')^2)}}.$$

[Note 3. A. *If two distances of a comet from the sun be* a *and* b, *and the intervening chord* c, *the perihelion distance* p *will be*

$$= \tfrac{1}{4}\cdot\frac{c^2 - (b-a)^2}{a+b-\sqrt{([a+b]^2 - c^2)}}.$$

The ordinates perpendicular to the axis at the respective points being x and $x+y$, we have $a = p + \frac{xx}{4p}$, $b = p + \frac{(x+y)^2}{4p}$, and $y^2 = c^2 - (b-a)^2$; consequently $b - a = \frac{2xy + yy}{4p}$, $\frac{x}{2p} = \frac{b-a}{y} - \frac{y}{4p}$, $\frac{xx}{4pp} = \frac{(b-a)^2}{yy} + \frac{yy}{16pp} - \frac{b-a}{2p} = \frac{a}{p} - 1$; but $\frac{(b-a)^2}{yy} + 1 = \frac{(b-a)^2 + c^2 - (b-a)^2}{yy} = \frac{cc}{yy}$, and $\frac{cc}{yy} + \frac{yy}{16pp} = \frac{b+a}{2p}$; whence $\frac{1}{pp} - \frac{8(a+b)}{pyy} = -\frac{16cc}{y^4}$, $\frac{1}{p} - 4\frac{a+b}{yy} = \sqrt{\left(\frac{16(a+b)^2}{y^4} - \frac{16cc}{y^4}\right)}$, $\frac{1}{p} = 4\,.\,\frac{a+b \pm \sqrt{([a+b]^2 - c^2)}}{c^2 - (b-a)^2}$; the conditions of the problem requiring the lower sign.

B. *Employing the same notation, we find* $\frac{x}{2p} = \frac{2a - \sqrt{([a+b]^2 - c^2])}}{\sqrt{(c^2 - (b-a)^2)}}$, x *being the first ordinate.*

For $\frac{x}{2p} = \frac{b-a}{y} - \frac{y}{4p} = \frac{b-a}{y} - y \cdot \frac{a+b-\sqrt{([a+b]^2-c^2)}}{yy}$ $= \frac{-2a+\sqrt{([a+b]^2-c^2)}}{y}$. It is obvious that $\frac{x}{2p}$ remains constant as long as a or r' is one of the distances compared.]

The two remaining equations are found by a comparison of the chords and distances from the sun with the observed intervals; whence we have

$$t' = \frac{\left(\frac{r'+r''+k'}{2}\right)^{\frac{3}{2}} - \left(\frac{r'+r''-k'}{2}\right)^{\frac{3}{2}}}{m\,3\sqrt{2}}$$

$$\mathrm{T} = \frac{\left(\frac{r+r'''+k''}{2}\right)^{\frac{3}{2}} - \left(\frac{r'+r'''-k''}{2}\right)^{\frac{3}{2}}}{m\,3\sqrt{2}}$$

m denoting the quantity employed in the same manner by Euler and Lambert. I am not aware that these four equations have before been exhibited in this manner in their simplest form.

[NOTE 4. C. *The area of the sector, comprehended between the distances* a and b, is $\sqrt{\frac{\mathrm{p}}{72}}\left[(\mathrm{a}+\mathrm{b}+\mathrm{c})^{\frac{3}{2}} - (\mathrm{a}+\mathrm{b}-\mathrm{c})^{\frac{3}{2}}\right]$

The area of the triangle contained by a, b, and c is $\frac{1}{4}\sqrt{[(a+b+c)(a+b-c)(a-b+c)(-a+b+c)]} = \frac{1}{4}\sqrt{([a+b]^2-c^2)}\sqrt{(c^2-(b-a)^2)} = \frac{y}{4}\sqrt{([a+b]^2-c^2)}$, and that of the remaining segment of the sector is equal to the area of a segment at the apex, of the same depth, and of the same breadth, y, or to $\frac{2}{3}y \cdot \frac{yy}{16p} = \frac{y^3}{24p} = \frac{y}{6}(a+b-\sqrt{([a+b]^2-c^2)}$; the sum being $\frac{y}{6}(a+b) + \frac{y}{12}\sqrt{([a+b]^2-c^2)}$, of which the square is $\frac{yy}{144}[2(a+b) + \sqrt{([a+b]^2-c^2)}]^2$, and this multiplied by $\frac{1}{p} = \frac{4}{yy}[a+b-\sqrt{([a+b]^2-c^2)}]$ gives $\frac{1}{36}(2e+f)^2(e-f)$ calling $a+b$, e, and $\sqrt{([a+b]^2-c^2)}$, f, or $\frac{1}{36}(4e^3-$

$3\,e f^2 - f^3) = \frac{1}{36}\,(e^3 + 3\,e\,c^2 - f^3)$ since $e^2 - f^2 = c^2$; but $e^3 + 3\,e\,c^2 = \frac{1}{2}\,(e+c)^3 + \frac{1}{2}\,(e-c)^3$; and since $f^2 = e^2 - c^2 = (e+c)\,(e-c)$, $e^3 + 3\,e\,c^2 - f^3 = \frac{1}{2}\,([e+c]^3 + (e-c)^3 - 2\,(e+c)^{\frac{3}{2}}\,(e-c)^{\frac{3}{2}}$, and the square of the area divided by p is $\frac{1}{72}\left([e+c]^{\frac{3}{2}} - (e-c)^{\frac{3}{2}}\right)^2$, consequently the area itself is $\frac{1}{6}\sqrt{\frac{p}{2}}\left([e+c]^{\frac{3}{2}} - [e-c]^{\frac{3}{2}}.\right)$

Cor. The time of describing a circle at the mean distance of the earth being called unity, and the time occupied by a comet of the same perihelion distance being less in the ratio of 1 to $\sqrt{2}$, the time for such a comet will be expressed by the area described, divided by $3.1416\,\sqrt{2}$, that is, by $\frac{1}{12\,\pi}\,([e+c]^{\frac{3}{2}} - [e-c]^{\frac{3}{2}})$; and since the area described is in the subduplicate ratio of the parameters, the same formula will express the time in all other cases; the units being the year and the earth's mean distance from the sun.]

§ 9.

If we consider these four equations with a little attention, we shall soon be convinced that it is perfectly impossible, in the present state of analytical science, to determine the three unknown quantities, ϱ', ϱ'', and ϱ''', immediately from them. For, supposing the patience of the calculator to be even sufficient to develope the equations completely, to free them from surds, and to substitute for r, k, x, y, and z, their values in terms of ϱ, he would still arrive at equations of so high a degree, in which the three unknown magnitudes, or at least two of them, if one were exterminated by means of the first equation, are involved with each other, that he could obtain no results whatever from them; and on this involution depends the insuperable difficulty of the problem. If, indeed, the second equation were as simple as the first, and if it enabled us to exterminate another of the unknown quantities, so that one only remained, we should easily find means to resolve the last two equations in a convenient manner, were they even still more intricate than the results of the elegant theorem of Lambert; and in this case it would be possible to

obtain at last even a linear equation, since the problem is more than sufficiently determined by three observations.

§ 10.

In the actual state of the problem, it has been necessary to have recourse to approximations and hypotheses. The method, particularly termed by Pingré that of false suppositions, which seems to have been first circumstantially indicated by Lacaille, may be mentioned, as the most inartificial, in the first place. A distance from the earth or the sun is arbitrarily assumed for the first observation; a distance is then found by trials for the third, so related to the former, that the time required for the description of the intervening space may agree with the observed time; we have then to find the place of the comet in the orbit thus determined at the time of the intermediate observation, and to compare it with the true place; and the whole operation must be repeated with new values for the first distance, until the whole of the results are found to correspond with the observations. This method has also been particularly explained by Pingré and Lalande, and it was generally employed in France until Laplace's solution was made public; but the German mathematicians have always thought it very tedious, and circuitous, and fatiguing. It must, however, be confessed that it is not extremely inconvenient, provided that the quantities assumed are tolerably near the truth; and it may be remarked, that the operation might be considerably shortened, if the theorem of Lambert were employed in it, which does not appear to have been hitherto done.

§ 11.

All other mathematicians, who have attempted the indirect solution of the problem, have employed some approximate hypothesis for reducing the problem to the investigation of one unknown quantity: for instance, a true or a curtate distance: and for this purpose two suppositions have been principally adopted, either (1) the portion of the orbit between the three observations has been considered as a straight line, described with a uniform velocity; or (2) it has simply been assumed that the chord of this portion of the orbit is divided by the revolving

radius, or by some other known line, in the proportion of the two intervals of time. Neither of these suppositions is perfectly correct, and the first is the least accurate; but either of them enables us to derive the chord, and consequently the whole orbit, from a single distance; and this distance must be obtained by conjecture, or by the "rule of false." These trials must be continued until they become near enough to the truth to enable us to find still more accurate values by interpolation. The same process may be employed in a geometrical construction; but the complication of a number of discarded lines will be found somewhat inconvenient.

§. 12.

The principal of these indirect methods of construction, or computation, will require to be briefly noticed. Boscovich supposes the portion of the orbit to be a right line, described with the velocity appropriate to the middle point, at least if Pingré has quoted him correctly. Lambert employs the supposition, that the chord is divided in the proportion of the times, and compares the magnitude of this chord with the whole time, by means of his own very elegant theorem. Newton, on the other hand, divides the chord much more accurately in the proportion of the times than it is divided by the revolving radius; and compares the length of the chord with the time, by means of a theorem which considerably resembles that of Lambert, although it is only an approximation. Hence it arises, that Newton's construction is the most accurate, Boscovich's the most convenient, and Lambert's holds the middle place in both respects. In all of them a distance from the earth is assumed for the middle observation; the position and length of the chord is then determined by the respective modes of approximation, and the time is compared with the length of the chord, according to the laws of motion in a parabola. Eüler also has employed the supposition, that the chord is divided in proportion to the times; but he has omitted to compare the space described by the revolving radius, with the whole time; and, instead of this, he determines an orbit in a conic section from

each trial, although still very far from the truth, without limiting it to a parabolic form, but proceeds to compute a fourth observation from the elements thus found, in order to judge of the accuracy of the first assumption. A labour so enormous, that no astronomer appears to have followed his steps in it; nor, indeed, has he himself adhered to this method, although the approximation which he employed in his researches on the comet of 1769 is little more convenient, and requires no further notice at present, any more than Newton's first method, published in his early work *De Mundi Systemate*, which it may be safely asserted that Newton had never attempted to reduce to practice in a single instance.

§ 13.

All these methods have some advantage over that of Lacaille, since the suppositions which they adopt supersede the necessity of some of the trials: for when a distance is once found which gives the whole time correctly, the middle observation, with which these calculations begin, must necessarily agree pretty accurately, without the repetitions which Lacaille's method requires for adjusting it. On the other hand, this method may be rendered ultimately more accurate, since (1) the supposition of the division of the chord is never mathematically correct: and (2) the observations employed can only be at small intervals from each other, for, otherwise, the error of the suppositions must be very considerable; hence the errors of observation will materially affect the results.

§ 14.

In order to supersede the necessity of these repeated conjectural trials, all the acuteness of talent, and all the artifices of calculation, possessed by the greatest mathematicians, have been repeatedly employed, and solutions of the problem have been successively made public by Lambert, Boscovich, Hennert, Duséjour, Lagrange, and Laplace.

§ 15.

Lambert thought it possible to reduce the whole to an equation of the sixth degree; but the equation is properly, as La-

grange has attempted to show, of a higher order, unless we admit a supposition, which, whether justly or not, he thinks objectionable. Boscovich, proceeding upon the same suppositions which he employs in his construction, has obtained an equation of the sixth degree, which affords a very correct approximation, if the observations are so accurate that they may be employed at short intervals of time. Lambert's second method is founded on some acute considerations on the apparent path of the comet; but it is wholly useless; at least neither Pingré nor myself could succeed in employing it with advantage, partly because great accuracy is required in the observations, and partly, because the suppositions concerned are not quite correct; at the same time it may sometimes be of use to apply the interesting theorem respecting the deviation of the apparent path of the comet from a great circle, to the purpose of deciding whether the comet is nearer to the sun than the earth, or not. The prize proposed by the academy of Berlin for the solution of the problem was adjudged to Mr. Von Tempelhof, and to M. De Condorcet; and the *accessit*, or second premium, to Mr. Hennert. I confess that I am not sufficiently acquainted with all these solutions, but I do not find that they have been much employed by practical astronomers. But the occasion seems to have excited the very valuable rival researches of Lagrange, Duséjour, and Laplace. Lagrange has given us three solutions of the problem, all depending on equations of the sixth, or of a still higher degree. The first of these he seems afterwards to have thought imperfect; indeed, Laplace has discovered a slight error in the calculation, and Pingré was unsuccessful in an attempt to apply it to practice. The second requires six observations, which must be near each other in pairs, and it leads by means of intricate calculations, to an equation of the sixth degree; it may, however, be sometimes of use, and Schulze has determined the orbit of the comet of 1774 by it with tolerable accuracy. The third, which is calculated to excite the highest admiration for the refinement of the analytical powers which it exhibits, requires a very laborious preliminary calculation, and then the solution of an equation of the seventh or

eighth degree. Duséjour has attempted to reduce every thing to equations of the second degree, with what success we shall see hereafter. Finally, Laplace has found means to apply a mode of interpolation to several remote observations, so as to obtain from the first and second differences the intermediate places, at any required intervals, however small. His solution depends on equations of the sixth or still higher degrees, and it would perhaps leave little further to be desired, if the preparations, and the manner of interpolation, did not commonly require much more time, and labour, and computation, than the solution itself. For further information respecting these methods, the reader may consult *Lambert, Insigniores Orbium Cometarum Proprietates; Scherfer, Institutiones Astronomiæ Theoreticæ; Lambert, Astr. Jahrb. Berl.* 1777; *Mém. Ac. Berl.* 1771; *Lagrange, Mém. Ac. Berl.* 1778, 1783; *Astr. Jahrb. Berl.* 1783; *Duséjour, M. Ac. Par.* 1779; *Laplace, M. Ac. Par.* 1780.

§ 16.

A general idea of the most useful of these solutions may be obtained without any great difficulty. Considering the intervals as infinitely small, we naturally assume, with Boscovich, that the portion of the orbit concerned is a straight line, described with uniform velocity. Hence the values of ϱ' and ϱ''' may be determined by a linear equation from ϱ''; or $\varrho' = \mathrm{H}\varrho''$, and $\varrho''' = \mathrm{G}\varrho''$, H and G being known coefficients: and we may consequently obtain the value of k'' in terms of ϱ'. The comparison of the time with the space described then gives us the expression $k'' \sqrt{r''} = m\mathrm{T}$: and if we exterminate all the irrational quantities, we come at last to an equation of the form $[k''^{4} r''^{2} = n^{2} \mathrm{T}^{4}]$, which is of the sixth degree, and is the simplest that can possibly express the conditions of the problem.

§ 17.

Much as there is to be admired in some of these investigations, and difficult as it may be to decide on their comparative value, it will still be readily granted, first, that they are all more or less imperfect approximations, requiring further correction,

since all of them neglect some small quantities which are not absolutely evanescent; secondly, that they are all, though in different degrees, much more troublesome than could be desired for a preliminary calculation; and, thirdly, that since no equations which exceed the fourth degree can be generally resolved otherwise than by approximation, those of the 6th, 7th, 8th, or still higher degrees, which occur in these solutions, must still require the employment of conjectural trials for obtaining the results to which they lead. It is probably for these reasons that practical astronomers have seldom employed any of them, except perhaps that of Laplace, but have adhered to the ancient methods of construction and calculation, which, notwithstanding their prolixity, they appear to have found more convenient.

§ 18.

In fact, the indirect nature of a calculation is by no means a reason for rejecting its employment; the only real inconvenience in the present instance arises from the multiplicity of trials required, and from the prolixity of the computations concerned in them; but the practical astronomer may often have reason to prefer an easier indirect method to a more elegant direct solution of the same problem. Even Laplace has substituted, in effect, for his direct method, a more practicable one, which is indirect.

§ 19.

The value of any mode of computation must be in the joint proportion of its conciseness, and of the accuracy of the result, on which the facility of the ulterior operations must depend. If the method described in the third section be appreciated upon this principle, I flatter myself that it will be considered as deserving the preference above all others. But we must, in the first place, examine the equations of the first and second degree, which have been proposed for the solution of the problem, since, if they were really applicable to the purpose intended, they would certainly afford the simplest and most convenient method of determining the orbit, and would supersede the necessity of inquiring for a new one.

(To be continued.)

ii. *Extract of a Letter from Dr. Olbers, of Bremen, dated* 29th *Nov.* 1819; *received* 11*th Feb.* 1820.

As soon as Professor Encke shall have completed his computations of the perturbations of the extraordinary comet, and formed an ephemeris of its apparent orbit for the time of its next re-appearance in 1822, I shall *immediately* communicate them to you, in order that the best possible use may be made of them. For, since this comet will arrive next at its perihelium in the middle of May 1822, it will be scarcely visible at that time in any part of Europe. Before its arrival at the perihelium it will be too remote from the earth, and afterwards it will be too far to the south to be seen by European observers. But in the southern hemisphere it will be beautifully conspicuous; and at the end of June, when its latitude will be 77° south, its light will be more than 26 times as strong as when it was discovered by Pons, on the 26th November 1818. It is therefore greatly to be desired that this comet should be watched and properly observed in the southern possessions of Great Britain, in particular at the Cape or at Botany Bay. For this purpose, the ephemeris of its motion should be sent out in good time, with proper instructions for its employment, and an astronomer should be found who might be capable of making the necessary observations.

For this, and for many other reasons, it is the general wish of all astronomers, who are attached to the science, that an observatory should be established at the Cape of Good Hope, furnished with all the instruments that are required in the present state of astronomy. In Europe, I imagine, there are a sufficient number of observatories, if a proper use were made of them. But, for the still further perfection of astronomy, it is absolutely necessary to compare the observations made in the northern hemisphere, with others made with similar instruments beyond the equator. The physical properties of the materials, of which our instruments are constructed, and by which they are supported and surrounded, notwithstanding the perfection of our artists, and the skill and attention of our astronomers, confine the precision of the observations within cer-

tain limits. But in an observatory situated in the southern hemisphere, all the causes, which distort our European observations by small errors which cannot be avoided, and which are with great difficulty discovered; small irregularities of refraction, for example, small flexures of the telescopes of our instruments, and other similar disturbances, would all operate in contrary directions; so that, by a comparison of both series of observations, the effects of these common causes of error might be discovered and removed. The Cape of Good Hope is so much the better situated for such an observatory, as it lies under a meridian which passes through the middle of Europe.

The great comet of last summer I was perhaps able to follow longer than most other astronomers. I saw it last on the 20th October, and on the 12th I obtained a good observation. Perhaps some of your friends would like to have my last observations, I therefore subjoin them.

	Mean Time Bremen.	Apparent A. R.	App. Decl. N.
	° ′ ″	° ′ ″	° ′ ″
1819. Sept. 17.	8 14 50	133 40 2	50 38 59
——— 19.	8 3 38	133 50 1	50 46 0
——— 24.	9 4 31	134 7 43	51 6 18
———	13 36 27	134 8 35	51 6 51
—— Oct. 12.	7 52 45	133 20 54	53 0 52

Besides General Von Lindener, two or three other observers here have announced that they had been looking at the sun's disc with telescopes on the 26th June 1819, at the time of the comet's transit. Lindener and one other person saw absolutely nothing on the disc; the other two maintain that they perceived a faint, confused, and ill defined spot. From these accounts, compared together, it may be inferred, that the nucleus of this comet must have been so transparent as only to occasion a slight obscurity on the part of the surface over which it passed, so inconsiderable as easily to have escaped observation.

iii. *Observations and Elements of the Orbit of the Great Comet of* 1819. *By the* Rev. J. Brinkley, D.D., F.R.S.

The remarkable comet, that appeared in July last, was observed at the observatory of Trinity College, Dublin, with the

excellent instruments at that observatory, *viz.*, by the transit instrument and astronomical circle, eight feet in diameter.

It rarely occurs that observations of a comet can be made on the meridian, and therefore the results of such observations may afford some interest. Dr. Brinkley computed the elements of the orbit from three observations made on the 4th, 5th, and 6th of July, and further corrected the elements so obtained by the observations of the 4th, 13th, and 20th of July. The result was as follows :

	D. H. ′ ″
Passage of perihelion, mean time at observatory, Trinity College, Dublin	June 27, 16 26 46
Perihelion distance..............	0,341051
	s ° ′ ″
Longitude of node..............	9 3 43 44
Inclination	80 45 53
Place of perihelion	9 17 5 5
Motion direct.	

The results of the comparisons of his observations and elements are as follow :

1819.	Mean time of observation at Ob. T. C. D.	Longitude by observation.	Latitude N. by observation.	Error of Elements in Long.	Error of Elements in Lat.
	h ′ ″	° ′ ″	° ′ ″	″	″
July 4	12 7 21,8	100 37 35,7	22 14 53,9	— 17,2	— 4,0
5	12 7 38,4	101 16 32,3	23 33 1,5	— 15,6	+ 4,2
6	12 7 46,4	101 54 0,0	24 39 30,4	— 15,3	— 14,8
13	12 4 29,0	105 41 6,4	28 52 5,3	+ 0,6	— 0,2
14	12 3 28,0	106 9 27,6	29 9 37,5	+ 5,6	— 0,7
15	12 2 21,3	106 37 10,0	29 24 26,1	— 1,5	— 1,1
20	11 55 13,3	108 43 50,1	30 9 58,5	+ 18,9	+ 3,3
21	11 53 33,2	109 7 14,4	30 15 7,7	+ 20,8	+ 8,2
24	11 48 5,4	110 14 24,1	30 25 52,5	+ 16,9	+ 14,9
28	11 39 57,9	111 36 44,9	30 33 3,9	+ 20,9	+ 13,9

In the above the comets' longitudes, and latitudes by observation are corrected for parallax and aberration, and the longitudes are reckoned from the mean equinox.

The faintness of the light of the comet prevented the continuance of exact observations by the meridian instruments, as the light barely sufficient for illuminating the wires entirely effaced the light of the comet.

The following very late observations, by Dr. Olbers, made at Bremen, have been compared by Dr. Brinkley with the above elements.

1819.	Mean time at Bremen.	Longitude by observation.	Latitude by observation.	Errors of Elements in	
				Long.	Lat.
	h ′ ″	° ′ ″	° ′ ″	′ ″	′ ″
Sept. 24.	9 4 31	121 8 59,3	32.18 34,5	+ 0 43,6	+ 1 24,0
Oct. 12.	7 52 45	119 51 26,4	33 57 19,7	+ 2 19,6	+ 2 19,3

Nothing in the above indicates that any elliptic orbit, that could be found, would be more to be depended on than a parabolic one; and it may be thought useless to endeavour to correct the elements, so that the very small errors exhibited may disappear, because the extent of the errors of observation in September and October, when the comet was so exceedingly faint must be uncertain. It was rather an object to ascertain the degree of precision that could be attained by the elements deduced from early observations near together.

The correctness of the elements, from the observation of the 4th, 5th, and 6th of July, deduced by M. Laplace's method by an exact computation, may be considered worthy of notice, as tending to shew the value of that method when applied to exact observations. They give the perihelion distance $= 0{,}3397$, and the time of passing perihelion, June $27^{d}\ 15^{h}\ 5'\ 28''$ for the first approximation.

Dr. Brinkley, as soon as he had made these observations, computed the elements by M. Laplace's method, merely to obtain the outlines of the orbit, and with only a few places of figures. Those elements appeared in the *Dublin Journal* of

July 14, and probably were the first elements published, and even when compared with the above, they must be considered as having some claim to exactness.

In correcting the first approximations, Dr. Brinkley employed a method, which, it is believed, has not been used before. Instead of changing the approximate perihelion distance, and approximate time of passage through perihelion by small quantities, as in M. Laplace's method, he obtained two equations in which the unknown quantities were the corrections of the perihelion distance, and of time of passage through perihelion.

This was done by investigating the fluxions of the anomalies, heliocentric longitudes, and latitudes, computed by help of the approximate perihelion distance, and approximate time of perihelion, and of three observations. This, at first sight, might be supposed to lead to intricate formulæ; but it is by no means the case. The operations will be found very considerably shorter than by M. Laplace's method, when great exactness is required. This method is particularly applicable in cases where it is necessary to investigate the elliptic orbit. Also, in M. Laplace's method, there is nothing by which the degree of exactness, required in the first approximate elements, to apply with advantage his method of corrections, is easily shown. The want of this may sometimes lead to very tedious calculations. Thus, in the present instance, considerable exactness is required in the first elements, when the observations of July 4th, 13th, and 20th, are used; because, on the first day, the angle at the comet was nearly a right angle, and the difference between the heliocentric longitudes of the comet and earth only amounted to a few degrees; and, on the second, the angle at the sun was nearly a right angle, and the difference of the heliocentric longitudes nearly 80°. It was on this account that Dr. Brinkley found it convenient to re-compute the first approximation with all the accuracy of which the observations were susceptible.

iv. *Lunar distances of Venus, computed by the Astronomers of the* Scuole Pie *at Florence.*

From *Zach's Corresp. Astr.* II. ii, iii.

♀ ☽ April 1820. Parisian Time.

Days.	Noon.			IIIh.			VIh.			IXh.		
17	15°	39′	59″	17°	6′	33″	18°	32′	52″	19°	58′	56″
18	27	5	27	28	30	3	29	54	23	31	18	29
19	38	15	9	39	37	49	41	0	18	42	22	33
20	49	11	29	50	32	49	51	54	2	53	15	6
21	59	58	39	61	19	11	62	39	39	64	0	0
22	70	41	33	72	1	50	73	22	9	74	42	28
23	81	24	47	82	45	26	84	6	10	85	27	0
24	92	12	44	93	34	14	94	55	52	96	17	39
25	103	8	52	104	31	36	105	54	32	106	17	38
26	114	16	1	115	40	17	117	4	45	118	29	26
27	125	36	4									

Days.	Midnight.			XVh.			XVIIIh.			XXIh.		
17	21°	24′	44″	22°	50′	17″	24°	15′	35″	25°	40′	38″
18	32	42	18	34	5	51	35	29	10	36	52	16
19	43	44	39	45	6	36	46	28	22	47	50	0
20	54	36	0	55	56	42	57	17	22	58	38	2
21	65	20	20	66	40	39	68	0	58	69	21	1[illegible]
22	76	2	50	77	22	14	78	43	41	80	4	14
23	86	47	55	88	8	57	89	30	6	90	51	21
24	97	39	35	99	1	40	100	23	54	101	46	18
25	108	40	55	110	4	24	111	28	5	112	51	57
26	119	54	20	121	19	26	122	44	46	124	10	18

Days.	Hor. Par.	Semid.	Days.	Hor. Par.	Semid.
1	7″,9	7″,3	21	8″,8	8″,0
11	8″,4	7″,7	30	9″,4	8″,5

♀ ☽ May 1820. Parisian Time.

Days.	Noon.			IIIh.			VIh.			IXh.		
14	18°	40′	59″	17°	10′	14″	15°	40′	23″	14°	11′	30″
15	6	55	2	5	30	29	4	11	52	3	3	20
16	5	24	39	6	45	46	8	8	3	9	31	20
17	16	29	1	17	52	27	19	15	46	20	38	57
18	27	32	49	29	55	9	30	17	23	31	39	34
19	38	28	57	39	50	32	41	12	7	42	33	45
20	49	21	9	50	42	37	52	4	8	53	25	40
21	60	14	12	61	36	8	62	58	10	64	20	18
22	71	12	55	72	35	52	73	59	0	75	22	18
23	82	21	43	83	46	14	85	10	59	86	35	57
24	93	44	34	95	11	4	96	37	50	98	4	53
25	105	24	22	106	53	7	108	22	11	109	51	32
26	117	22	47	118	53	57	120	25	24	121	57	10

Days.	Midnight.			XVh.			XVIIIh.			XXIh.		
14	12°	42′	48″	12°	14′	46″	9°	47′	2″	8°	21′	57″
15	2	9	55	2	18	21	9	56	41	4	7	59
16	10	54	43	12	18	9	13	41	42	15	5	26
17	22	2	0	23	21	52	24	47	37	26	10	17
18	33	1	39	34	23	32	35	45	23	37	7	13
19	43	55	16	45	16	35	46	38	1	47	59	35
20	54	47	16	56	8	53	57	30	35	58	52	21
21	65	42	34	67	4	56	68	27	27	69	50	6
22	76	45	48	78	9	28	79	33	21	80	57	25
23	88	1	10	89	26	38	90	52	21	92	18	19
24	99	32	13	100	59	49	102	27	42	103	55	53
25	111	21	11	112	51	8	114	21	23	115	51	56
26	123	29	13									

Days.	Hor. Par.	Semid.	Days.	Hor. Par.	Semid.
1	9″,4	8″,5	21	10″,6	9″,9
11	10″,1	9″,3	31	13″,6	12″,4

♀ ☽ JUNE 1820. Parisian Time.

Days.	Noon.			IIIh.			VIh.			IXh.		
12	23°	12′	58″	21°	44′	32″	20°	16′	22″	18°	48′	28″
13	11	33	39	10	7	49	8	42	30	7	17	58
14	2	18	5	2	49	1	3	48	39	5	2	9
15	11	49	35	13	13	3	14	36	36	16	0	12
16	22	58	47	24	20	31	25	46	16	27	10	0
17	34	8	54	35	32	45	36	56	39	38	20	35
18	45	21	22	46	45	48	48	10	21	49	35	1
19	56	40	36	58	6	13	59	32	2	60	58	2
20	68	11	26	69	38	50	71	6	30	72	34	26
21	79	58	32	81	28	16	82	58	21	84	28	44
22	92	5	49	93	38	18	95	11	9	96	44	22
23	104	36	11	106	11	41	107	47	34	109	23	50
24	117	30	53	119	9	23	120	48	18	122	27	12
25	130	48	46									

Days.	Midnight.			XVh.			XVIIh.			XXIh.		
12	17°	20′	51″	15°	53′	33″	14°	26′	33″	13°	19′	55″
13	5	56	45	4	41	46	3	37	1	2	48	45
14	6	21	3	7	41	53	9	3	46	10	26	22
15	17	23	52	18	47	34	20	11	18	21	35	2
16	28	33	46	29	57	31	31	21	17	32	45	4
17	39	44	36	41	8	39	42	32	49	43	57	2
18	50	59	50	52	24	47	53	49	53	55	15	9
19	62	24	16	63	50	42	65	17	23	66	45	17
20	74	2	40	75	31	10	76	59	59	78	29	6
21	85	59	28	87	30	32	89	1	57	90	33	42
22	98	17	58	99	51	57	101	26	18	103	1	3
23	111	0	29	112	37	31	114	14	56	115	52	45
24	124	7	7	125	47	2	127	27	18	129	7	53

Days.	Hor. Par.	Semid.	Days.	Hor. Par.	Semid.
1	14″,6	14″,4	21	18″,5	18″,3
11	15″,5	15″,5	30	21″,1	20″,7

In JULY, Venus is too near the Sun for observation.

Art. XVI. *Miscellaneous Intelligence.*

I. Mechanical Science.

I. §. Astronomy, Hydrodynamics, &c.

1. *New Comet.*—A new comet was discovered at Marseilles, on the 28th of November, by M. Blanpain, in the south wing of the constellation Virgo. Its angular diameter was about six or seven minutes. A very small and confused nucleus has been observed, but no tail whatever. On the 29th, Nov. 6 h. 10′ A.M. true time, it had 138°. 7′ right ascension; 3° north declination. On the 30th, 5 h. 45′ A.M., right ascension 184° 1′; north declination 1°. On the 2nd of December, at 5h. 6′, A.M., right ascension 185° 1′, north declination 2° 3′.

2. *Comet.*—It is now ascertained that one and the same comet returned to our system in 1786, 1795, 1801, 1805, and 1818-19. It appears never to range beyond the orbit of Jupiter. Its short period of little more than three years and a quarter, and its mean distance from the sun, which is not much greater than twice that of the earth, connect it in a particular manner with that part of the system in which we are placed; it crosses the orbit of the earth more than sixty times in a century.

3. *On the force of a jet of Water.*—M. J. Morosi, member of the Imperial Institute of Milan, has published an account of a new phenomenon in hydrodynamics, which promises to be of considerable utility in the application of that science. In consequence of the establishment of a manufactory at Milan, in which the power of water was to be applied, M. Morosi commenced a course of experiments, to determine the force of a stream or jet of water. They were made by directing the jet of water against a round disc, and estimating the force exerted on it by a balance. In this way, which is the usual method employed, an expression of the force of the water was obtained. But M. Morosi observed, that in the experiments, the

water which had passed against the disc was thrown off in a lateral direction all around with a velocity scarcely inferior to that with which it first moved, so that much of the force possessed by the jet of water was not brought into action on the disc, but was expended in the production of this lateral stream; and he concluded, that if in any way this could be accumulated on the disc, the effect would be much greater. To obtain, in part, this end, a rim of the height of six lines was raised round the edge of the disc, so as to form it into a kind of dish; and then, without changing any other circumstance in the experiment, it was repeated. In the first case the power exerted on the disc equalled nine pounds twelve ounces of Milan, now it was increased to twenty pounds.

These experiments were made with a reservoir of water, ten feet (French) high, having an aperture in its side, near the bottom, four inches square; to this aperture was adapted a pyramidal canal, which, at its external orifice, was an inch in the side; so that the section of the stream of water was a square inch, but the length of the canal and the size of the disc, against which the water struck, are not mentioned; the disc was placed vertically at such a distance from the orifice, as to correspond with the maximum of contraction in the jet of water.

The following table exhibits some other results obtained by this apparatus: the first column expresses the height of the water; the second, the power exerted on the plain disc; and the third, the power exerted on the disc with the raised edge.

6 feet high.	5 ℔. on plain disc.	11 ℔. on edged disc.
8 ———	7 ℔. ———	15 ℔. ———
10 ———	9 ℔. ———	20 ℔. ———

In consequence of these results M. Morosi objects to the methods generally employed by philosophers to estimate the force of a jet of water, since they do not give half the effect which may be obtained from the same jet by other means. He also thinks that the result observed by the Abbé Zubiani, namely, that a stream of water received on to an iron disk, exerts more force than if received into a wooden one, may be

accounted for by the stronger affinity of contact between the iron and the water, than between the wood and the water, producing an effect of retardation in the lateral current, similar to that produced by the rim in these experiments. Ultimately he applied the contrivance of the rim in the construction of the water-wheels for the manufactory before-mentioned; making them on the same principle as the edged disc. The wheels were horizontal, revolving round a vertical axis, the floats were placed in a canal as on vertical wheels, and were guarded by rims, rising two inches from the surface. The passages for the water were of a pyramidal form, and passed horizontally from the bottom of the reservoir containing the water destined to move the wheel, forming tangents to the surface of the wheel; apertures were left at their under edge to permit the water to escape, after having struck the floats. The mouth of each passage was contained within the rims on the floats, so that the whole effect of the moving water was exerted on the plane opposed to it.

In consequence of this arrangement, M. Morosi found the quantity of water allotted him to be more than sufficient to move the machines which were required: and a still better proof of the value of the principle on which the wheels were constructed afterwards occurred. Being called away after the construction of the wheels, they were left in other hands, and in some attempts to work them with a smaller quantity of water, the rims were removed from the floats. In consequence of this, all attempts to move them by the water were vain, and as those who then managed them refused to believe that such simple means as the rims could improve them, they were left inactive for some time. When M. Morosi returned, his first care was to restore the rims; on which the wheels again worked, and have continued to work since.—*Bibliothèque Universelle*, xii. p. 217.

4. *Improvement on Scissors.*—A very valuable improvement has been made on scissors. It is especially so to those employed for delicate operations in surgery. The objection to the com-

mon scissors is, that in the act of cutting they, to a very considerable extent, compress and bruise the parts. This is owing to the edges being set very strong, and on an angle, generally of about degrees, and is sufficient to account for wounds made by scissors, refusing to unite by what surgeons call the first intention. To remedy this defect, it was lately suggested to Mr. Stodart, by Dr. Wollaston, to give to scissors the same kind of cutting edge that a knife has. This has been done, and the success has fully justified the experiment. The operation of hare lip has been repeatedly performed with the knife-edged scissors, both on the infant and on the adult, with complete success. The operation is in this way performed with facility to the operator, and in less time than with the knife; and, consequently, a less degree of pain to the patient. This improvement need not be confined to the science of surgery. A variety of delicate fancy-work is performed by scissors, all of which will be much better done by giving them knife edges. There is a little art in setting the edges readily acquired by practice; this must be done with a view to the kind of work for which the scissors are intended. This improvement may easily be applied to common scissors, by grinding down the outer sides of the blades.

5. *Clocks.*—The first clock known in France was erected, in the fifth century, in the cathedral church at Lyons. Gondebaut, or Gombaut, III., King of Burgundy, having been informed that Theodoric, King of the Goths, who, at that time, resided at Ravenna, had machines which marked the order of time according to the movements of the heavens and stars, wrote to him, requesting to have one. Theodoric gave orders to the celebrated Boccius to make two such, as perfect as possible, and tnen sent them to Gondebaut, with an excellent letter, which may be seen in the works of Cassiodorus, secretary of state to Theodoric, who was accustomed, towards the end of his life, after he had retired from public life, to amuse himself with making quadrants, clocks, *&c.*—*Zach's Correspondence.*

6. *New Musical Instrument.*—A new musical keyed instru-

ment is described as the invention of M. Schortmann, of Buttstead. The tones are produced by short rods of burnt wood, of various lengths and breadths, put into vibration by a current of air. Its pianissimo perfectly resembles the Æolian harp, and it is described as imitating the harmonica, clarinet, horn, hautboy, and violin, with much exactness.

7. *New Acoustical Machine: The Siren.*—This instrument, intended to measure the number of vibrations of the air required for the production of a sound, is the invention of the Baron Cagniard de la Tour. It was constructed on the idea, that if, as is generally admitted, the sound of instruments is occasioned by the regular impulses given to the air by their vibrations, then any mechanical means of striking the air with the same regularity and velocity should produce sound.

The method consists in passing air from a bellows, by a small orifice which is covered by a circular plate, moveable on a centre, at a little distance on the side of the aperture. This plate has a certain number of oblique holes made through it in a circle round the axis, which passes over the orifice of the bellows, and the holes are placed at exactly equal distances from each other. When the plate is made to revolve, which from the obliquity of the holes may be done by the current of air itself, or otherwise by mechanism, the aperture is alternately open and shut to the passage of the air, by which means a regular series of blows are given to the external air, and produces sound analogous to the human voice, and more or less acute, according to the greater or lesser rapidity of the plate.

In the instrument, in place of one aperture many are used, which are opened and shut simultaneously, by which means, without interfering with the height of the sound, its strength is increased. The instrument is a circular copper box, four inches in diameter; the upper surface of this box is pierced by a hundred oblique apertures, each a quarter of a line in width, and two lines long; on the centre of this surface is an axis, upon which the circular plate moves; this plate has also a hundred apertures, corresponding to those below, and with an

equal obliquity, but in an opposite direction. The obliquity is not necessary to the production of sound, but it serves to give motion to the plate by the passing air. The box is connected by a tube with a bellows, that supplies it with air.

In the experiments made to ascertain the vibrations for each sound, the plate was made to revolve, by wheel-work, put in motion by a weight; the bellows were then put in action, only for the purpose of judging whether the sounds of the machine accorded with the notes of a standard instrument. This instrument was the harmonica, consisting of an arrangement of iron or steel bars, made to vibrate by a bow.

Thus disposed, the machine was made to produce the diatonic notes of the gamut, and even some beyond them; the revolutions of the plate were estimated by the revolutions of a wheel, which turned with a velocity thirteen times and a half less than that of the plate.

The following table is the result of these experiments, but the inventor of the instrument intends to refine and improve his machinery, and then repeat and extend them.

Notes.	No. of revolutions made by the wheel in 1′.	No. of revolutions made by the plate in 1″.	No. of vibrations produced in 1″.
la	19	$4\frac{27}{100}$	427
si	$21\frac{1}{4}$	$4\frac{77}{100}$	477
ut	$22\frac{3}{4}$	$5\frac{11}{100}$	511
re	25	$5\frac{67}{100}$	567
mi	28	$6\frac{30}{100}$	630
fa	30	$6\frac{75}{100}$	675
sol	34	$7\frac{65}{100}$	765
la	38	$8\frac{55}{100}$	855
si	$42\frac{1}{2}$	$9\frac{55}{100}$	955
ut	$45\frac{1}{2}$	$10\frac{23}{100}$	1023
re	50	$11\frac{25}{100}$	1125

The first la corresponds to the second of the harmonica, and is the unison of the common diapason.

If water be passed into the Siren in place of air, it produces sound, even though the whole instrument be immersed; and

the same number of concussions produces the same sound as in the air. In consequence of this property of being sonorous in the water, the instrument has been called the Siren.—*Annales de Chimie*, xii. p. 167.

II. Chemical Science.

§ Chemistry.

1. *Separation of Magnesia and Lime.*—The separation of these two earths has, at different times, gained a good deal of attention, both from the frequency with which they occur together, and the difficulty with which they are accurately separated. M. Longchamp has, in the *Annales de Chimie*, added a long paper to those already published, on this subject, the most important part of which is in substance as follows:—

Oxalate of ammonia is objected to, because a portion of oxalate of magnesia is precipitated at the same time with the oxalate of lime.

Subcarbonate of ammonia is considered as the best means of separating the two earths, but care must be taken to filter the solution from the precipitate which falls on its addition to mixed salts of lime and magnesia, shortly after it is added; otherwise, if it stand twelve or eighteen hours, subcarbonate of magnesia falls with the carbonate of lime; 100 grammes of pure muriate of lime, gave, with subcarbonate of ammonia, 1.5475 grammes. 100 grammes of the same solution, previously mixed with much muriate of magnesia, so that the latter earth was in largest quantity, gave a precipitate of 1,5585 grammes of carbonate of lime.

Alkaline subcarbonates dissolve the subcarbonates of magnesia. Well washed moist subcarbonate of magnesia was agitated, and left in contact with solution of subcarbonate of potash, or soda, for twenty-four hours; then being filtered, the clear liquor deposited subcarbonate of magnesia on being heated, but still retained some in solution, as was shewn by adding caustic potash. A cold solution also retains more of the magnesia than a hot one; 100 parts of sulphate of magnesia,

precipitated by subcarbonate of potash, heated, and filtered whilst hot, gave 24.75 parts; another 100 parts, precipitated, heated, and then allowed to stand for 24 hours, gave only 18.845 parts; and a third 100 parts, precipitated without heat, gave but 13.9 parts.

Caustic potash precipitates magnesia perfectly, either with or without heat.

Objections are taken to the method of separating lime and magnesia, by first converting them into sulphates; first, because of the great difficulty of driving off the water from the sulphate of magnesia; second, because of the difficult solubility of heated and dry sulphate of magnesia in water; and third, because of the decomposition in part of the sulphate of magnesia by long and high heats. A heat of 260°, (centigrade?) for five hours, dissipated only about $\frac{4}{5}$ of its water. A white heat for three quarters of an hour did not drive off the whole. Heated for three quarters of an hour to whiteness, it began to lose acid, and was not again perfectly soluble. When heated, it is difficultly soluble in water; it requires eight or ten times the quantity of water required for the common sulphate of magnesia, and to be left many hours in contact with it; and this effect is produced by a heat by no means extraordinarily high. Some that was dried in phials, in a sand bath, was as tardy in dissolving as that which had been dried at a white heat.

The conclusions contained in the paper are—1. That the subcarbonate of ammonia is the best agent to separate lime from magnesia. 2. That fixed alkaline subcarbonates, though heated, precipitate magnesia imperfectly. 3. That carbonate of magnesia is soluble in alkaline salts. 4. That caustic potash precipitates magnesia perfectly; and that it, or caustic soda, should always be used for the precipitation in analysis, 5. That sulphate of magnesia, long calcined, even at low heat, is difficultly soluble in water. 6. That magnesia, heated to whiteness, retains 20.78 per cent. of water.

The following tables express the composition of certain magnesian compounds.

Sulphate of Magnesia.

Magnesia	13.249
Sulphuric acid	33.751
Water	53
	100

	Hydrate of Magnesia.	Sub Hydrate of Magnesia.
Magnesia	52.997	79.218
Water	47.003	20.782
	100	100

Magnesia.

Magnesium	49.174
Oxygen	50.826
	100

Ann. de Chim. p. xii. 255. See Mr. Phillips on the subject, p. 313, Vol. VI., and p. 392, Vol. VII., of this Journal.

On the Nature of Prussian Blue.—In addition to the number of chemists who have turned their attention to this subject, M. Robiquet has also engaged himself upon it, and given some interesting details to the public. He has observed, as has been done by Mr. Porrett, that the white precipitate, caused by adding prussiate of potash to proto-sulphate of iron, contained potash, however perfectly it be washed; and he therefore observes that it may be considered as a compound intermediate between the triple prussiate of potash and Prussian blue. Whilst acid is present it is insoluble, but when that is removed by repeated washing, the salt becomes somewhat soluble in water.

When sulphuric acid is added to Prussian blue, or rather the pure prussiate of iron, it makes it perfectly white, without liberating any odour of prussic acid; if water be added to it, the blue colour immediately returns. The sulphuric acid appears to separate nothing but water in this case, for if it be withdrawn from off the white precipitate, it is found to afford no traces of prussic acid or of iron. The experiment also succeeds perfectly in *vacuo*, so that the air has nothing to do in it. M. Ro-

N 2

biquet admits, however, that the idea may be entertained of the white compound being an union of the Prussian blue and sulphuric acid.

On submitting Prussian blue (pure) to the action of sulphuretted hydrogen in solution for some time, small brilliant crystals of a yellowish colour appeared, which became blue in contact with the air, and were proto-prussiate of iron.

M. Robiquet has succeeded in obtaining the acid of Prussian blue in a solid crystalline state, by a process different to that of Mr. Porrett's. Strong muriatic acid, in large quantity, is mixed with Prussian blue (pure,) and, left for some time, the sediment becomes of a green colour, and then yellow; if water be added to this mixture, it is again rendered blue, but if no water be added, and it be allowed to stand in a narrow vessel, the sediment falls to the bottom, and a deep red brown solution covers it; this is an acid solution of muriate of iron, and cannot be made to produce a blue by any method tried. The sediment was allowed to contract itself for several days, and the supernatent liquor drawn off by a little syphon, the washing was then repeated with concentrated muriatic acid as before, until the process was supposed complete. The magma was then collected into a capsule, and placed in a receiver, containing much lime, to dry. When dry, it was digested in alcohol, filtered and evaporated spontaneously, and a number of small crystals were obtained. These crystals were separated, washed in fresh alcohol, dissolved, and again crystallized, and were then the pure acid of Prussian blue, or the ferro chyazic acid of M. Porrett.

These crystals appear at times to be tetrahedral; they are white when pure, but become slightly blue by exposure to the air. They have no odour, their taste is acid and peculiar, without being like that of prussic acid. They are soluble in water and alcohol. The colourless solution produces an immense precipitate of Prussian blue in persulphate of iron. The acid perfectly saturates potash, and produces the common triple prussiate of potash. If it be heated, a considerable quantity of prussic acid first passes off, the remainder becomes of a deep

blue colour, and insoluble. When heated in close vessels, the prussic acid is given off as before, perfectly pure, and no other effect takes place, if the temperature be below that of boiling mercury. The residue is yellowish brown, but becoming nearly black in the air, it contains ammonia, and the iron is in such a state of combination, that it is not affected either by sulphuric acid or the magnet. If this residuum be heated still higher, then prussic acid in small quantities, and hydrogen and azote, in the proportion of one to two, come off, and charcoal and metallic iron remain. No carbonic acid is found in this experiment; hence the iron is in the metallic state in the acid. M. Robiquet concludes from this experiment, that the peculiar acid is a combination of prussic acid and cyanuret of iron, formed, by affinities, so powerful, that the poisonous properties of the prussic acid are entirely neutralized and lost.

"It results (says M. Robiquet,) from what has been said, 1. That potash is an essential element in the white prussiate of iron. 2. That the triple protoprussiate of iron is slightly soluble in water, capable of being crystallized, and of a yellow colour. 3. That the acid of Prussian blue, and of triple prussiate in general, is a combination of iron, cyanogen, and prussic acid. 4. That Prussian blue, and the triple prussiates in general, are formed of a cyanuret and a hydrocyanate. 5. That it is probable that Prussian blue owes its colour to a certain quantity of water.—*Annales de Chimie*, xii. p. 277.

3. *Refractive Powers of Muriatic Acid.*—Mr. H. Creighton, whilst making experiments on the formation of compound lenses, to correct abberration, observed a remarkable law in the refractive power of muriatic acid of different density, the refractive power being nearly as the density of the acid employed. The table below exhibits the focal distances with acids of different strengths. The two double convex lenses were of crown glass, the focus of one about 24, and of the other 27 inches; when placed together, the focus was about 13 inches, and when the space between them was filled with water and acid, the focal distances were as in the second column of figures; the

first column expresses the specific gravity by experiment; the third column, that deduced from the focal distances.

		Inches.	
Water	1.000	23.75	1.000
Sol of muriatic acid	1.055	25.	1.053
———————	1.087	27.7	1.088
———————	1.121	26.6	1.121
———————	1.146	27.	1.138
———————	1.177	28.	1.180

With nitric and sulphuric acids the specific gravities increased at a much greater rate than the focal distances.

4. *Formation of Ammonia.*—Mr. R. Phillips has added another process to those already known, illustrative of the composition and formation of ammonia. When phosphoric acid is formed by the action of nitric acid on phosphorus, water is decomposed at the same time with the nitric acid, the hydrogen and nitrogen combine, and ammonia results; so that, after the action, the fluid contains phosphoric acid, nitric acid, and ammonia. The presence of the latter is easily ascertained, by adding a portion of potash or lime to the acids, so as to neutralize them. The heat occasioned by the action, volatilizes the ammonia.

5. *Change of Voice by Hydrogen.*—Mr. Cooper has ascertained that if hydrogen gas be breathed for a few moments, it has the curious effect of changing the voice. The effect is observed, on the person speaking immediately after leaving the vessel of hydrogen, but it soon goes off. No instance has yet occurred in which this effect on the voice has not been produced by the hydrogen.

6. *Acetate of Alumine.*—M. Colin has observed that, if white clay be digested in the pyrolignious acid, before its purification by combination with a base, that it dissolves and diminishes the colour of the acid very much. This solution may be made perfectly colourless by animal charcoal, and is so highly charged with alumine, that it becomes a magma, on the addition of ammonia. The clay had been previously washed with weak

muriatic acid. This preparation would probably be of use in dyeing and the arts.

7. *On testing different Metals by Cupellation.*—M. Chaudet has made some experiments on the means of detecting the metals of alloys by the cupelling furnace, and they promise useful application. The testing depends on the appearances exhibited by the metals and their alloys, when heated on a cupel. Pure tin, when heated this way, fuses, becomes of a greyish black colour, fumes a little, exhibits incandescent points on its surface, and leaves an oxide, which, when withdrawn from the fire, is at first lemon yellow, but when cold, white. Antimony melts, preserves its brilliancy, fumes, and leaves the vessel coloured lemon-yellow when hot, but colourless when cold, except a few spots of a rose tint. Zinc burns brilliantly, forming a cone of oxide, and the oxide much increased in volume, is when hot, greenish, but when cold perfectly white. Bismuth fumes, becomes covered with a coat of melted oxide, part of which sublimes, and the rest enters the pores of the cupel; when cold, the cupel is of a fine yellow colour, with spots of a greenish hue. Lead resembles bismuth very much; the cold cupel is of a lemon-yellow colour. Copper melts, and becomes covered with a coat of black oxide; sometimes spots of a rose tint remain on the cupel.

Alloys. Tin 75, antimony 25, melts, becomes covered with a coat of black oxide, has very few incandescent points. When cold the oxide is nearly black, in consequence of the action of the antimony. A $\frac{1}{400}$ part of antimony may be ascertained in this way in the alloy. An alloy of antimony, containing tin, leaves oxide of tin in the cupel; $\frac{1}{100}$ part of tin may be detected in this way. An alloy of tin and zinc gives an oxide, which, whilst hot, is of a green tint, and resembles philosophic wool in appearance. An alloy, containing 99 tin, 1 zinc, did not present the incandescent points of pure tin, and gave an oxide of greenish tint, when cold. Tin 95, bismuth 5 parts, gave an oxide of a grey colour. Tin and lead gave an oxide of rusty brown colour. An alloy of lead and tin, containing only one per cent. of the latter metal, when heated, does not expose a clean surface like lead, but is covered at times by oxide of tin. Tin 75,

and copper 25, did not melt, gave a black oxide; if the heat be much elevated, the underpart of the oxide is white, and is oxide of tin; the upper is black, and comes from the copper. The cupel is made of a rose colour. If the tin be impure from iron, the oxide produced by it is marked with spots of a rust colour.—*Annales de Chimie*, xii. p. 342.

8. *New Yellow Dye, for Wool, Silk, Cotton, Flax, &c.*—M. Braconnot has lately applied realgar, or the sulphuret of arsenic, in the manner of a dye to various materials, and from the success he has met with, has no doubt it will become valuable to dyers. The dye-stuff is made by dissolving sulphuret of arsenic in ammonia, but it requires certain precautions to succeed in doing this: 1 part of sulphur, 2 parts of the white oxide of arsenic, and 5 parts of common pearl-ash, are to be fused in a crucible, at a heat a little below redness; a yellow mass results, which is to be dissolved in hot water, and filtered. The filtered solution, diluted with water, is to be treated with weak sulphuric acid, and will give a very fine yellow precipitate. When washed, it dissolves with great facility in ammonia, forming a solution at first yellow, but becoming colourless by the addition of more ammonia. The wool, silk, cotton, or linen is to be dipped in this solution, more or less diluted, according to the colour required, care being taken that no metallic vessels be used. On taking them out again they are at first colourless, but as the ammonia evaporates become yellow. They are to be exposed to free access of air on all sides, and then washed and dried. Wool should be left in the liquor until perfectly impregnated with it, and on being withdrawn should be only slightly wrung, or even not at all. Silk, cotton, and flax, merely require immersion, and should have the excess of fluid wrung from them.

This dyeing material has the power of giving all shades of yellow, and is very permanent in the air: alkalies, and consequently soap, injure it, but for taffeta, velvet, and other manufactures of that kind, it offers many advantages.—*Annales de Chimie*, xii. p. 398.

9. *Preservation of Crystals.*—It is sometimes an object to preserve good crystals of salts, especially with those who are attentive to the study of crystallography. In attaining this end much assistance may be derived from the use of sweet oil. Many crystals, which change and become dull by exposure to air, as alum, sulphate of copper, sulphate of iron, prussiate of potash, *&c.*; if slightly oiled, do not then alter in a long time, and many efflorescent substances are prevented from changing by the same means. Even crystals of Glauber's salt will lie exposed to the air for weeks together without efflorescing, if well oiled. The best method is to soak the crystals in oil for a few hours, and then to wipe them, and put them up in bottles.

10. *Pink Sediments of Urine.*—Dr. Prout says, "I lately had an opportunity of examining the most marked specimen of pink sediment I had ever seen. It consisted almost entirely of the lithate of ammonia. Pink sediments in general consist either of this substance, or of the lithate of soda, mixed with more or less of the phosphates. When the lithate of soda and the phosphates prevail, the sediment usually assumes the form of what has been denominated the lateritious sediment. In specimens of this latter description I have several times found *nitric acid*, and in all cases I have satisfied myself that the red colour of these sediments depends upon some slight mixture of the purpurate of ammonia or soda, according as the sediment itself consists of the lithate of ammonia or soda. Perhaps the formation of the purpuric acid may be explained, by supposing that the nitric and lithic acids are secreted together, and that the purpuric acid, or rather the purpurate of ammonia, is formed by the action of the nitric upon the lithic acid.—*Thomson's Annals*, xv. p. 155.

11. *Test for Olive Oil.*—If the pernitrate of mercury, made by dissolving 6 parts of mercury in 7.5 parts of nitric acid, of sp. gr. 1.36., at common temperatures, be mixed with olive oil, in the course of a few hours the mixture, if kept cold, becomes solid, but, if mixed with the oil of grains, it does not solidify.

M. Poutet proposes, therefore, this substance as a test of the purity or adulteration of olive oil; for the resulting mixture, after standing 12 hours, is more or less solid, as the oil is more or less pure. The nature of the white, hard, and opaque mixture, formed by olive oil, and the nitrate of mercury, has not been examined.

12. *Purification of Water.*—The waters of the Mississippi are very turbid, and yet are considered as very healthy. The following simple method of purifying it, is adopted at times. A handful of *Indian meal* is sprinkled on the surface of a pailful of the water, which precipitates the mud to the bottom, and the superincumbent water is left in a tolerable state of purity.—*Schoolcroft*, p. 234.

13. *New Vegetable Alkalies—Brucine.*—The discovery of morphium has excited very great attention in France, and active endeavours have been made in search of other bodies belonging to the class of vegetable alkalies. These have been rewarded lately by the discovery of two new ones, called *brucine* and *delphine*, so that, with strychnine and morphium, their number amounts already to four, supposing no mistake has been made in the characters and distinctions of any of them.

Brucine has been described, in a paper read to the Institute of France, on the 19th of June, 1819. It was obtained from the Angustura bark * *(Brucœa anti-dysenterica,)* by the following process: A kilogramme (32 oz. troy) of the bark was reduced to powder, and acted on by ether to remove certain impurities; the ether being withdrawn, alcohol, in successive portions, was made to act on it, and the different infusions, added together and evaporated to separate the alcohol. The extract was then dissolved in water, precipitated by subacetate of lead, filtered, and the excess of lead separated from the solution by sulphuretted hydrogen. As strychnine was the substance looked

* The author constantly calls this the false Angustura bark.

for, this solution, thus far purified, was acted on by magnesia, an alkali became evident in this way; but on washing the magnesia, it passed off in solution, and did not remain insoluble, as would have been the case with strychnine. On evaporating the washings, a solid mass, of a very alkaline nature, was obtained: it was the new alkali. Still further to purify it, the alkali was combined with oxalic acid, which formed a salt very little soluble in alcohol; it was then well washed in that fluid, until the salt was colourless; then being decomposed by lime, or magnesia, the alkali was liberated, and, being afterwards dissolved in boiling alcohol, was obtained in crystals by spontaneous evaporation.

Brucine, regularly crystallized, is in the form of oblique quadrangular prisms, sometimes several lines in length; they are colourless and transparent. If rapidly crystallized, as from a hot saturated aqueous solution, it takes on the form of nacreous plates, like boracic acid. It dissolves in 500 parts of boiling water, and 850 of cold water; but when impure, it is much more soluble. It has a bitter acrid taste. When taken in a dose of a few grains, it proves poisonous, but not so much so as strychnine. It does not alter in the air. It melts at a heat a little above boiling water, without decomposition, and when it cools again, appears like wax. When decomposed by oxide of copper, it gave much carbonic acid and water, and a very little nitrogen, which appeared to be accidental.

With acids it forms neutral and acid salts, readily capable of crystallizing. The sulphate of brucine takes on the form of long fine needles, which, appeared to be four-sided prisms. It is very soluble in water, and slightly so in alcohol; it is very bitter; it is decomposed by potash, soda, ammonia, barytes, strontia, lime, and magnesia. It is also decomposed by morphium and strychnine, which dissolve readily in it. It is not decomposable by any of the acids, except perhaps the nitric, which alters the brucine itself, and, as with strychnine, produces a fine red colour. If sulphuric acid be added to a neutral solution of sulphate of brucine, a rapid crystallization is frequently occasioned, and a supersulphate formed, which may be washed

with ether. These crystals are larger than those of the neutral salt, and retain their acid after several solutions and crystallizations. An analysis of the neutral salt gave—

Sulphuric acid	8.84	9.697
Brucine	91.16	100.

The sulphate of strychnine and morphium are composed as follows:

Sulphate of strychnine, sulphuric acid	9.5	10,486
	90.5	100.
Sulphate of morphium, sulphuric acid	11.084	12.465
	88.916	100.

The muriate of brucine is easily obtained in quadrangular prisms, terminated by oblique faces. They are unalterable in the air, and very soluble in water; if heated, at a certain point they decompose, and the muriatic acid escapes in white vapours. It is decomposed by sulphuric acid, and by those bases which decompose the sulphate. When analyzed it gave—

Brucine	94.0467	100.
Muriatic acid	5.9533	6.331

agreeing extremely well with the calculations made of its composition.

Muriate of morphium gave, morphium	91.7115	100.
	8.2885	9.0375
and muriate of strychnine gave, strychnine	92.9227	100.
	7.0723	7.6102

These also agree pretty nearly with the calculations.

The neutral phosphate of brucine is soluble uncrystallizable salt. When more acid is added, the supersalt formed, crystallizes readily, and forms large rectangular tables. It is very soluble in water, effloresces slightly in the air, and is soluble in strong alcohol at common temperatures.

The neutral nitrate of brucine does not crystallize, but forms a gummy mass by evaporation, but, on the contrary, the supersalt crystallizes readily in acicular quadrangular prisms. These are readily distinguishable from the nitrate of strychnine, which

are a neutral salt. When the crystals are heated they redden, then blacken, and lastly inflame. If the nitric acid be in great excess, a fine red colour is produced, as with strychnine, and the cause, as with that substance, seems to be a peroxygenation of the alkali, for all those bodies which absorb oxygen, as proto-muriate of tin, sulphuretted hydrogen, sulphureous acid, *&c.*, destroy the colour. If the action of the acid be continued, or heat be applied, the colour passes to yellow, and if to the yellow solution proto-muriate of tin be added, an intense violet colour is produced.

The acetate and oxalate of brucine are the only salts that have yet been found with this alkali, and vegetable acids. The acetate is soluble and incrystallizable; the oxalate, as well as the super-oxalate, very crystallizable.

The action of brucine on the animal system is analogous to that of strychnine, but, compared with it, its force is not more than as 1 to 12. It induces violent attacks of tetanus; it acts on the nerves without attacking the brain, or injuring the intellectual faculties. It required four grains to kill a rabbit, and a dog having taken three grains suffered severely, but overcame the poison. It is suggested, that the alcoholic extract of the Angustura bark may be used with advantage in place of the extract of the vomica nut.

It appears that this alkali is combined in the bark with gallic acid; the bark contains, besides, a fatty matter, gum, a yellow colouring matter, sugar, in very small quantities, and ligneous fibre.—*Annales de Chimie*, xii. p. 113.

14. *Delphine.*—This vegetable alkali has been discovered by MM. Lassaigne and Feneulle, in the stavesacre, *(Delphinium staphysagria.)* It is obtained thus: The seeds, deprived of their husks and grounds, are to be boiled in a small quantity of distilled water, and then pressed in a cloth; the decoction is to be filtered, and boiled for a few minutes with pure magnesia; it must then be re-filtered, and the residuum left on the filter, when well washed, it is to be boiled with highly rectified alcohol, which

dissolves out the alkali, and, by evaporation, it is obtained as a white pulverulent substance, presenting a few crystalline points.

It may be obtained also by acting with dilute sulphuric acid on the seeds, unshelled but well bruised, the solution is to be precipitated by subcarbonate of potash, and the precipitate acted on by alcohol: but, obtained in this way, it is very impure.

Delphine, when pure, is crystalline whilst wet, but, on drying, rapidly becomes opaque by exposure to air. Its taste is bitter and acrid. When heated it melts; and, on cooling, becomes hard and brittle like resin. If heated more highly it blackens, and is decomposed. Water dissolves a very small portion of it. Alcohol and ether dissolves it very readily. The alcoholic solution renders syrup of violets green, and restores the blue tint of litmus, reddened by an acid. It forms neutral salts with the acids, which are very soluble; the alkalies precipitate the delphine in a white gelatinous state, like alumine.

Sulphate of delphine evaporates in the air, does not crystallize, but becomes a transparent mass like gum. It dissolves in alcohol and water, and has a bitter acrid taste. In the voltaic current it is decomposed, giving up its alkali at the negative pole.

Nitrate of delphine, when evaporated to dryness, is a yellow crystalline mass. If treated with excess of nitric acid, it become converted into a yellow matter, little soluble in water, but soluble in boiling alcohol. This solution is bitter, is not precipitated by potash, ammonia, or lime-water, and appears to contain no nitric acid, though itself is not alkaline. It is not destroyed by further quantities of acid, nor does it form oxalic acid. Strychnine and morphium take a red colour from nitric acid, but delphine never.

The acetate of delphine does not crystallize, but forms a transparent hard mass, bitter and acrid, and readily decomposed by cold sulphuric acid. The oxalate forms small white plates, resembling in taste the preceding salts.

Delphine calcined with oxide of copper gave no other gas

than carbonic acid. It exists in the seeds of the staves-acre, in combination with malic acid, and in company with the following principles:—1. A brown bitter principle precipitable by acetate of lead. 2. Volatile oil. 3. Fixed oil. 4. Albumen. 5. Animalized matter. 6. Mucus. 7. Saccharine mucus. 8. Yellow bitter priciple, not precipitable by the acetate of lead. 9. Mineral salts.—*Annales de Chim.* xii. p. 358.

15. *Analysis of Zinc Ores by Mr. Cooper.*

DEAR SIR, 89, *Strand, March* 16, 1820.

MY friend Mr. L. Potts, of Truro, placed in my hands last summer two minerals, requesting me to undertake an examination of them; one of which I consider to be the mineral termed Brown Mammillated Blende, and the other I do not recollect to have seen described, unless it be that which is called Silicate of Zinc. I have accordingly analysed them, and find their component parts as stated beneath. The mineral is of a chocolate brown colour within, but externally of an ash gray; its fracture choncoidal and somewhat shining; streak bright brown. Before the blow-pipe it melts and white vapours are given off, and it becomes black; if the heat be continued for a sufficient length of time it is nearly dissipated. I find 100 parts of it to contain of

Zinc,	61.5
Sulphur,	30.8
Arsenic,	4.8
Ox. iron,	1.8
	98.9

The other mineral is found as a coating upon quartz in pseudomorphous crystals of a dark gray colour, nearly approaching to black; the exact form of the crystal I have not been able to determine, but to the best of my judgment they appear to be truncated cubes. When heated before the blow-pipe it decrepitates, and if the heat be urged to great intensity (such as by a mixture of oxygen and hydrogen, or by oxygen through the flame of a spirit lamp,) it melts into an opaque yellow enamel which becomes nearly white on cooling. 100 parts contain

Ox. Zinc	51.5
Silica,	39.2
Water,	6.4
Ox. iron,	.2
	97.3

The best inferences I can draw from these experiments are, that the first of these substances is a compound of

One atom of zinc, and
One atom of sulphur,

with a mixture of arsenic and oxide of iron, which bears no relative proportion, and may therefore be considered as extraneous; and the second is a quaternary compound of

One atom oxide of zinc,
One atom of water, and
Two atoms of silica,

and may therefore be considered as a hydrated bisilicate of zinc.

In the above statement of the atomic constitution of these substances, I have considered the weight of the atom of zinc as 33, and that of its oxide as 41, but I by no means consider these numbers as correct, for I have endeavoured during my experiments on these minerals to determine the true weight of the atom of zinc, but have never been able to obtain two results that agree nearer than 4 or 5 parts in 100, but if I took the average of six or seven operations they give me as a mean result 31.943. I conceive the difficulty to arise from the tendency which zinc has to form triple salts with the alkalies, more particularly with potash and ammonia, which renders the mode of obtaining cadmium, recommended in a former Number of your Journal, rather fallacious, unless great care is taken to use none of the substances in excess, and I am not sure even then whether it may be implicitly relied on,—at least it will not succeed in my hands: for if to a solution of nitrate of zinc I add ammonia in excess to dissolve the oxide, and subsequently a solution of potash, oxide of zinc will precipitate, (and so would cadmium, if any was present); if the oxide of zinc is separated, and the clear solution boiled, a triple salt will form, which is a

compound of nitric acid, oxide of zinc, and potash: and if the boiling was continued for some time, a second triple salt will form, which is a compound of nitric acid, oxide of zinc, and ammonia.—I remain, *&c.*

JOHN THOMAS COOPER,
Teacher of Chemistry, and Analytical Mineralogy.

III. NATURAL HISTORY.

§ MINERALOGY, MEDICINE, &c.

1. *Native Iron.*—" A mass of native iron, weighing upwards of three thousand pounds, was discovered several years ago on the banks of Red River in Louisiana, and is now in the collection of the Historical Society in the New York Institution. Its shape is irregular, inclining to oviform; its surface deeply indented, and covered by an oxide of iron, and it is much broader at the bottom, where it has rested on the earth, than at the top, inclining somewhat in the manner of a cone. By several experiments which have been made upon different pieces of it, there appears to be a want of uniformity in its quality, some parts being very malleable and ductile, while others possess nearly the hardness of steel. It is susceptible of the highest polish, and is said to contain some nickel. Colonel Gibbs, through whose munificence this rare specimen of the physical productions of our country has been placed among the collections of the Historical Society, has discovered in its interior, octohedral crystals of singular beauty, some of which are half an inch in length, and striated. This mass of iron was found about one hundred miles above Natchitoches on Red River, on one of those rich and extensive prairies so common to that part of the country, and about twelve miles from the banks of the river. Other pieces have been found in that neighbourhood, and if reliance is to be placed on the information from travellers in that quarter, very large masses of native iron now exist there." —*Schoolcroft, Lead Mines of Missouri.* p. 217.

2. *Supposed Meteoric Iron at Aix-la-Chapelle.*—A mass of ferruginous matter was observed, in the year 1762, whilst re-

pairing one of the streets of Aix-la-Chapelle, buried in the earth. It was removed about the year 1814 from that situation, and has frequently since been mentioned as meteoric iron. An analysis of it has been made, which gave as its principles, iron, arsenic, sulphur, and various earths. M. Clerc has since then examined this mass, and he concludes that it is not meteoric, but the production of an ancient furnace. Some specimens of the mass contained crystals of pyrites disseminated through them; and on an examination of the block itself, fragments of argillaceous schist were found adhering to one extremity, and penetrating even into the mass. Part of the specimen which had been analyzed when examined by a lens, was found to contain a fragment of brick sufficiently large to be seen by the naked eye. These circumstances were sufficient to convince M. Clerc, and those who assisted him in the examination, that the mass was not meteoric, but had the origin assigned it above.

3. *Micaceous Iron Ore.*—The only granitic rock in the inhabited part of the Missouri territory is situated in the neighbourhood of La Motte. It ranges from S.E. to N.W., about twenty miles in length and six in breadth. It contains some remarkable bodies of micaceous iron ore. A vein of it, several feet wide, occurs on the banks of the river St. Francis at the *Narrows*, Madison county; but the most remarkable mass is called the Iron Mountain, where the ore lies in such quantity as to form a lofty ridge elevated from five to six hundred feet above the plain, and half-a-mile in extent.—*Schoolcraft, Lead Mines of Missouri.*

4. *Nitre Caves of Missouri.*—" On the banks of the Merrimack and the Gasconade are found numerous caves which yield an earth impregnated largely with nitre, which is procured from it by lixiviation. On the head of Current's river are also found several caves from which nitre is procured, the principal of which is Ashley's Cave on Cave Creek, about eighty miles S.W. of Potosi. This is one of those stupendous and extensive caverns which cannot be viewed without exciting our wonder

and astonishment, which is increased by beholding the entire works for the manufacture of nitre situated in its interior. The native nitrate of potash is found in beautiful white crystals, investing the fissures of the limestone rock which forms the walls of this cave; and several others in its vicinity exhibit the same phenomenon."—*Schoolcraft, Lead Mines of Missouri.*

5. *Hot Springs of Ouachitta. (Washitaw.)*—These springs, which have been known for many years, are situated on a stream called Hot-spring Creek, which falls into the Washitaw river eight miles below. They lie fifty miles south of the Arkansaw river, in Clark county, territory of Arkansaw, (lately Missouri,) and six miles west of the road from Cadron to Mount Prairie on Red River.

The approach to the springs lies up the valley of the creek. On the right of the valley rises the hot mountain with the springs issuing at its foot; on the left, the cold mountain, which is little more than a confused and mighty pile of stones. The hot mountain is about 300 feet high, rising quite steep and presenting occasionally ledges of rocks, it terminates above in a confused mass of broken rocks. The steep and otherwise steril sides are covered with a luxuriant growth of vines. The valley between this and the cold mountain is about fifty yards wide.

The springs issue at the foot of the hot mountain at an elevation of about ten feet above the level of the creek; they are very numerous all along the hill-side, and the water which runs in copious streams is quite hot; it will scald the hand and boil an egg hard in ten minutes. Its temperature is considered that of boiling water, but Dr. Andrews, of Red River, thinks it is not above 200° Fahr. There is a solitary spring situated seventy feet higher than the others on the side of the mountain, but it is of an equal temperature and differs in no respect from those below. A dense fog continually hangs over the springs and upon the side of the hill, which at a distance looks like a number of furnaces in blast. To this fog, condensed into water, is attributed the rank growth of the vines on the side of the mountain.

Very little is known of the chemical nature of the water; an analysis is said to have been made which indicated a little carbonate of lime. An abundance of beautiful green moss grows at the edges of the springs, and the paths of their waters are marked by a brighter vegetation than occurs elsewhere. The rocks formation here are limestone, slate, and quartz.—*Schoolcroft, Lead Mines of Missouri.* p. 258.

6. *Burning Spring.*—"A phenomenon which has for several years excited the attention of travellers, under the name of a burning spring, exists in one of the principal forks of Lecking river Kentucky. It is situated about three-fourths of a mile from the banks of the river, and about eighty miles above its junction with the Ohio, opposite Cincinnati. A spring here breaks out at the foot of a hill, forming a basin of water about six feet in diameter and two feet deep, at the bottom of which issues a stream of gas, which in volume and force is about equal to the blast forced from a common smith's bellows; but there is no cessation of its force, which is such as to create a violent ebullition in the water. Being heavier than common atmospheric air, the gas on passing up through the water constantly occupies the surface which is still the lower part of an indenture in the earth at that place. On presenting a taper this gas instantly takes fire, and burns with great brilliancy, There is no absorption of it by the water, which possesses the purity of common spring water, neither is any offensive odour thrown off. This spring has been known to dry up entirely in the summer, when the air rushes out with increased force, accompanied by a hissing noise. There is nothing like smoke emitted."—*Schoolcroft, Lead Mines of Missouri.* p. 216.

7. *Height of Monte Rosa.*—M. de la Pierre who ascended Monte Rosa in the August of last year, found the spot which he gained, and which is generally called the summit, to be 4521.77 metres (33,530 feet,) high. From some trigonometrical observations made in haste, some of the other points about the great sea of ice were found to be still higher, and even

to exceed Mont Blanc in height, but these measurements want verification.—*Bibliothèque Universelle,* XII., p. 143.

8. *Temperature beneath the Earth's Surface.*—The thermometer placed in the caves at Paris varied last year only $\frac{1}{50}$ of a degree; the mean result is 11.697, (53°.05 Fahr.,) and is above the mean temperature of the atmosphere by half a degree.

9. *Formation of an Island.*—A curious island has been formed within the last few years in the Bay of Bengal, by the accumulation of alluvial matters brought together by the waters that flow into the Bay. It was not visible four or five years ago, but was discovered in 1816, together with the canal, by vessels trading to Saugur. Its situation is 21° 35′ latitude, and 88° 20′ east longitude from Greenwich, agreeing precisely with that assigned to the bank of Saugur. The island is at present only a sand-bank, but is continually receiving rapid additions. It is about two miles long from east to west, and half-a-mile wide from north to south. At the western extremity are little elevations, and it is high enough in the centre to afford shelter, except during the violence of a tempest. The south shore consists of fine solid sand with a gentle declivity. In some parts the island is covered with and manured by the dung of birds. Myriads of small crabs cover the northern shore. The central part appears at a distance like a green lawn; herbage has taken root there, and there are a number of tufts of long *cass, (saccharum spontaneum,)* that thrive very well. It is visited at present only by fishermen, who have raised two huts on it in honour of Siva, an Indian divinity. The canal that separates the island from Saugur is well stocked with fish, and the southern shore is frequented by tortoises.

10. *Dr. Wilson Philip's Experiments.*—In consequence of a paper which appeared in this Journal relating to a repetition of an experiment of Dr. W. Philip, by three Fellows of the Royal Society, a correspondence has taken place between him and Mr. Brodie, (recently published in two medical Journals,) from which it appears that Mr. Brodie, who was one of the abovementioned gentlemen, allows there was in the repetition of the

experiment a deviation from Dr. W. Philip's method which might have affected the result; but observes that he has again repeated it without success, and moreover, that in this second repetition the state of the stomach was not quite the same as in the first, but corresponded with that related at p. 232 of Dr. W. Philip's "*Inquiry,*" in which the stomach was exposed only to a slight degree of galvanic influence.

11. *New Febrifuge.*—A new febrifuge has been introduced into Spain, which promises to be of much value in the Materia Medica. It is the root of a plant known to the Indians of Quito under the name of Chinininha, and named by Dr. Joseph Pavor, who considers it a new genus, *Unamica Febrifuga.* Dr. Joseph Pavor presented this plant to the Royal Academy of Medicine at Madrid, and several eminent men in medical science were appointed to try its virtues and its applications. Their results are entirely in favour of this new medicine, and have been confirmed by the experience of many others. The powdered root is employed in doses of a scruple up to half a drachm every three hours, and thus in a short time fevers have disappeared, and the recurrence of those which intermit prevented, though they had for months resisted the action of cinchona and other remedies. The powder has been distributed to the various medical schools, of Madrid; and in every successive trial has preserved the good character it first obtained.

12. *Remedy for the Plague.*—The use of olive oil has lately been recommended as a very effectual remedy for the plague. It was strongly praised some years ago by Mr. Baldwin an English consul in the East; and in the month of June, last year, Mr. Graberg writes from Tangiers, that by drinking from four to eight oz. of it a number of patients have been saved from death. The remedy acts generally as a sudorific, an abundant sweat breaks out all over the body; it sometimes proves vomitive and purgative, but the sweating is most salutary. Its use has been recommended for trial in disorders allied to the plague.

§ Meteorology, Electricity, &c.

1. *Meteorological Prize Question.*—The following subject is to be rewarded by the Academy of Dijon in 1821, by a gold medal of 300 francs value :

" How far, in the present state of natural philosophy, can aqueous meteorological phenomena be explained ?" The memoirs to be sent to the secretary of the academy, before March 1, 1821, accompanied by a closed billet, as usual.

2. *Conductor for Lightning.*—M. Capestolle, a French professor of chemistry, affirms, that a rope of straw will form an excellent conductor for lightning, and supply the place of metallic conductors. M. Capestolle's confidence appears to be founded on the circumstance, that if a strongly charged Leyden jar be touched with a rope of straw held in the hand no shock is felt, or spark perceived, yet the phial is discharged. It is to be hoped that but few persons will trust to this new kind of conducting-rod.

3. *Red Snow of the Alps, from the neighbourhood of St. Bernard.*—The editors of the *Bibliothèque Universelle*, in illustration of this subject, had engaged the prior of the convent of Great St. Bernard, to make his observations on the red snow found in the neighbourhood of his convent, and to answer a series of questions drawn up respecting it. The result of his answers is as follows : It is permanent; always occurs in the same place, generally plains at the foot of inclined surfaces, covered with snow ; does not colour snow that falls on it. It is found at the heights of Buet, St. Bernard, Col de la Seigne, and Bonhomme ; and also above and below, if masses of snow exist large enough to remain through the summer. It is found sometimes on the glaciers. It is most abundant after strong winds from the west and south-west; occurs two or three inches in depth; is most abundant as the summer advances ; is found in the greatest quantities, and most highly coloured, in the beds of the

small streams formed by the melting waters on the surface of the snow; is observed most frequently where the snow resists solution longest. No one has seen it fall. The prior thinks it is earthy and ferruginous; that it is caused by particles brought by the winds, or sometimes by currents of water. He says that no superstitious opinions are connected with it. It is not to be obtained before the middle of June.

Two portions of this coloured snow were furnished by the prior to M. Peschier, who analyzed them. No. 1, had an earthy appearance, and a ferruginous dirty-yellow colour; heated, it lost a tenth of its weight, and deepened in colour; 100 parts gave—

Siliceous matter	65.5
Alumine................	6.35
Per oxide of iron	21.35
Organized matter	6.8
	100.

No. 2. appeared like a coarse vegetable earth, in which the eye could distinguish fragments of lichen, &c. It came from a spot of red snow, above which a red tint was observed, supposed by the prior to be caused by the decomposition of a cryptogamous plant; this kind of snow is rare, and occurs only in small spots. When strongly heated, it gave out strong fumes of burning vegetable matter, and 100 parts lost 40. The residuum was brilliant, and of a violet colour; 50 grs. of it, distilled in the fire, gave an ammoniacal liquor, a few drops of an empyreumatic oil, and 32 grains of a charry residuum; 100 parts, on analysis, gave,

Insoluble matter	20.
Alumine	4.25
Per oxide of iron................	31.25
Lime..........................	.5
Insoluble organized matter	37.5
Soluble organized matter	6.5
	100.

Afterwards, two bottles of water were obtained for examination. No. 1. from a snow which, in June, covers larger spaces, and of a fine rose tint. The water of this bottle gave nothing particular. The insoluble residuum in it, treated by alcohol, gave a small portion of a yellow resinous substance; 25 parts of the residuum gave,

Silex	14.18
Per oxide of iron	3.25
Alumine	1.75
Lime	.1
Resinous principle	3.2
Organic matter	4.
	26.48

The increase in weight is attributed to water.

The water, No. 2, when filtered, contained a little carbonic acid and lime, and reddened litmus paper. The residuum was rough, and mixed with small fragments of crystal; 25 parts gave,

Silex	1.25
Per oxide of iron	12.34
Lime	.2
Organic matter and water	10.
	23.79

The conclusions are, that the coloured snow of the Alps is reddened in two different ways; 1. by a greater or less quantity of per oxide of iron spread over its surface. 2. By a vegetable and resinous principle, of a red orange colour, belonging apparently to the organization of a cryptogamous plant, of the order of algæ, or the lichens.—*Bibliothèque Universelle*, xii. p. 264.

4. *Coloured Rain.*—On the 2d of November, 1819, between 2 and 4, P.M., rain fell at Blankenberge, which, for a quarter of an hour, was of a deep red colour, and afterwards what fell gradually resumed its ordinary appearance. This phenomenon drew the attention of Messrs. Meyer and Stoop, chemists, of

Bruges, who procured some of the water, analyzed it, and have published an account of it in the *Annales Générales de Sciences Physiques*, published at Bruxelles. 144 oz., evaporated to 4 oz., became of a deep black colour, but deposited no precipitate. It was neither acid nor alkaline; sulphuric acid liberated chloric acid from it? nitrate of silver precipitated chloride of silver; deuto-nitrate of mercury precipitated *calomel*; hydrosulphuret of potash threw down a black precipitate, which was reduced by heat to the *metallic* state. The liquor which had been *precipitated* by the nitrate of silver, mixed with solution of potash, gave a precipitate of a purple colour, which, properly treated, yielded three grains of a hard brittle metal, of a greyish-white colour, attracted by the magnet, and yielding, with borax, a fine blue glass. Hence those chemists conclude, that the acid was the chloric, (perhaps muriatic is meant,) the metal *cobalt;* and the rain a solution of muriate of cobalt.

There are many mistakes in this account, and we cannot resolve that the whole is not one: nevertheless, it is asserted that the red rain fell all over the place, and that plenty of blue glass has been made from its contents.—*Annales de Chimie*, xii. p. 431.

5. On the night of the 2d and 3d of November, coloured rain also fell at Schweningen, of a red colour. It is described as having had the taste of filings of iron, mixed with sulphur.

6. *Fall of Black Powder from the Air.*—During the night of Tuesday, 16th November, there fell, in the township of Broughton, North America, on the south shore, so great a quantity of a black powder, as completely to cover the snow which was then on the ground.

7. *Temperature in India.*—The following short meteorological journal may be interesting, from having been kept in a part of the world, from whence there are not many observations, and in a low latitude. It contains an instance of the sudden diminution of temperature, which is said frequently to occur in India at the moment of sun-rise.

Date.	Time.	Wind.	Hygrometer.	Thermometer, Shade of Tent.	Thermometer, Exposed	
Tuesday, 10th Jan. 1809.	A.M.					
	6.	..	Dry.	40	33	At half-past six o'clock in the morning we marched from Lahore.
	8.	NW. by W.	..	..	50	From 7 A.M. to 3 P.M. a smart breeze from the northward. 4 P.M.
	12.	..	..	..	74	serene.
	P.M.		..			
	42.	..	..	66	61	
	6.	..	..	55½	51	Clear, and stars very bright.
	10.	..	..	44½	40	Ditto, and very frosty.
Wednesday, 11th Jan. 1809.	A.M.					
	6.	..	Dry.	40	32	At 6 A.M. day-light had just appeared. At 6¼ marched from Moody'
	6½.	N. by W.	..	..	26	At 6½ sun-rising, and excessive cold. Hoar-frost, so great that the grass,
	8.	..	..	..	57	crackled under our feet.
	12.	..	..	70½	67½	
	P.M.					
	4.	..	..	68	63½	Light breeze, and very clear all the morning.
	6.	..	..	58	51½	Clear, very dry, and stars very bright.
	10.	..	..	47	39	Ditto, ditto, ditto.
Thursday, 12th Jan. 1809.	A.M.					
	6.	..	Damp.	41½	34	At Umritsir, cloudy, thick, and very misty.
	8.	..	..	35	43	———— ditto, ditto, ditto.
	10.	..	Dryish.	61½	66½	———— cloudy, thick mist.
	12.	S.W.	..	66½	69½	———— ditto, and light breeze.
	P.M.					
	2.	N.W. by W.	..	69	71	———— ditto, light airs.
	4.	..	Dry.	66	66	———— ditto, ditto.
	6.	..	Damp.	60½	55	———— very thick mist.
	10.	..	..	48	43½	———— thickish, but stars appearing.

While in the suite of C. T. Metcalfe, Embassador to Lahore, from the Honourable East India Company, the accompanying Meteorological Journal was kept.

On Wednesday, 11th January, 1809, at half-past six o'clock in the morning, the thermometer fell to 26° Farenheit's; at this time it was exposed on an open plain, and the sun's rays were darting through the atmosphere. This, I have somewhere seen considered as the reason why it is generally so much colder in India, at or about the time of sun-rise, than at other times.

The village of Moody, near which the above low temperature was observed, is about 15 miles east of Lahore, and in north latitude 31° 30′.

BENJAMIN BLAKE,
Captain in the Bengal Army.

8. *Falling Stars.*—SIR, Whilst passing through the Straits of Bahama, in the autumn of 1799, I witnessed the following singular atmospheric phenomenon. Should a short notice of it be worth recording, it may possibly find a place in your Journal.

It was a fine star-light morning, about two o'clock, the atmosphere remarkably clear, with a light air from the N.E., the sky to windward from N.N.E. to S.S.E. was illuminated by a profusion of those meteors, vulgarly denominated falling stars, but of a description far more vivid than those usually seen in the higher latitudes; the head of each was an oblong ignited mass, followed by a long luminous tail, which, after three or four seconds, gradually vanished. They were formed, to all appearance in the air at an elevation of from 35 to 64°, none being observed in the zenith, and few to commence nearer the horizon than the first-mentioned angles. At the mean of these elevations the greatest number were seen darting in different directions, forming portions of a large curve all slightly inclined to the horizon. Multitudes were constantly visible at the same moment, and they succeeded each other so rapidly that the eye of the spectator was kept in motion between the above points of the compass. In about ten minutes they became less frequent, and at length ceased altogether.

The apparent distance of this phenomenon would, by a seaman, be estimated at fifteen or twenty miles, and if it really was what I have always considered it, namely, a nocturnal shower of meteoric stones, it was perhaps fortunate for all on board we were not within the sphere of its action; whatever it was, never shall I forget the splendour of the spectacle.—I remain, *&c.*

THO. BAGNOLD.

See *Humboldt's Personal Narrative*, Vol. III., p. 331, 335.

9. *Earthquakes.*—A very violent shock of an earthquake happened at Corfu on the 11th of September last, and in an instant set the bells of the churches ringing. The time was nine in the evening; the moon shone very bright, and the air was quite serene. Earthquakes here are generally ascribed to eruptions of Vesuvius or Etna.

A strong earthquake also occurred at Comrie in Perthshire, about half-past one o'clock in the morning of November 28th. It was more powerful than any that has happened there for the last ten years. It continued for nearly ten seconds, with the usual hollow grumbling noise, and whilst passing immediately under the place, very much disturbed the timber of the houses, and the moveable things in them. It extended several miles round the village, and appeared to commence in the north-west, and pass in a south-easterly direction.

A slight shock of an earthquake was felt at Montreal, preceding an awful storm which occurred there about the middle of November last, and rain fell of an inky colour and apparently impregnated with a matter like soot.

About half-past seven o'clock in the evening of December 4th, a smart shock of an earthquake was felt at Amulree, in Scotland. It lasted two or three seconds. Its direction was by the Grampian hills eastward. Houses and furniture shook, and the whole went away with a noise like the slow passing of carts.

The shock of an earthquake was felt on the morning of the 20th of December, about 7h. 55′, at Mittenwald, in Bavaria. It lasted seven or eight seconds, and passed from south to north. The wind from the south was very still.

At the time of the earthquake which so dreadfully devastated the territory of Kutch in India, shocks were felt at other places considerably removed from that neighbourhood. An earthquake happened at Chunar and Mirzapore on the same day, (June 16,) about eight in the evening, and at Chunar the motion is described as being accompanied by a noise in the air like the rapid flight of birds. A slight agitation of the earth took place also at the same time at Calcutta. At Jionpoor the shock was strong, and there were three distinct vibrations from west to east. It occurred about half past eight o'clock, lasted nearly 25 seconds, and was not accompanied by any rumbling noise. At Sultanpoor, Oude, the shock is described as being very severe and awful. The weather was very hot at both these latter places, and no rain had fallen.

A strong earthquake occurred at Port Glasgow, about half past eight o'clock in the morning of 22d January. There were three distinct shocks, and the rumbling noise which preceded them seemed to come from the north, as well as the heaving of the earth. A rapid thaw had commenced that morning, succeeding a long and sharp frost. At the same time the waters in Loch Lomond were agitated and rose somewhat, and some persons who were crossing it were alarmed by the sudden rippling of the water. The earthquake was felt also at Condrie, Perthshire, Keppin, Dumbarton, *&c.*, at the same time.

10. *Insulation of Electricity.*—M. Haüy in his method of distinguishing precious stones, *&c.*, has called in the aid of electricity; joining the electric indications given by a gem when rubbed or pressed to its other physical characters. That these indications may be obtained more readily, M. Haüy has invented two small instruments, very portable and ready, to furnish the

two kinds of electricity. One of them is a small bar of Iceland spar fixed to the end of a needle or lever, which is then suspended by the middle so as to be balanced by a thread of silk. When the spar is pressed between the fingers it becomes positively electric, and then the electricity of another body, however excited, as of a gem by friction, is ascertained by its attraction or repulsion of the spar. The second instrument is formed of a piece of sealing-wax flattened at one end so that it may stand on a table, and at the other supporting the point of a needle ; a needle of silver or copper terminated at the extremities by beads, moves on this as on a centre. To charge this apparatus a piece of amber or sealing-wax is to be excited negatively by friction, and then by touching the needle it becomes similarly electrified, and is then ready to indicate by attraction or repulsion the kind of electricity possessed by another body.

M. Haüy has lately remarked upon the extreme permanency of the electrical states of these two apparatuses. His attention was drawn to this circumstance from the perfection of their action during extremely moist weather, and he was induced to make a few experiments on the subject. The permanency of the electricity excited on the spar depends on the difficulty of adhesion between it and water. In damp weather no moisture deposits on it, so that electricity given to it is perfectly retained. Even if it be dipped in water and afterwards pressed without wiping, it becomes strongly electric, because no water adheres to its surface to conduct the power away ; and M. Haüy at last ascertained that immersion in water was not sufficient to remove electricity previously communicated to it. The permanency, therefore, of its electric state in the atmosphere, and the value of this property, may easily be conceived. If the water be rubbed on the surface of the crystal so as actually to wet it, then no electricity is generated by pressure, and what may have previously been generated is of course dissipated.

M. Haüy has observed also that fluate of lime and the euclase also acquired electricity by pressure, though not so

powerfully as Iceland spar; and he found them also to possess similar relations to water.

During his experiments on the electricity of minerals, M. Haüy found that the second apparatus also had the power of preserving its electric state unimpaired for a long time; a circumstance scarcely to be expected from its construction. In examining the apparatus this power was found to depend on the sealing-wax foot; for if that were removed and the needle hung by silk, though it readily took electricity from other bodies yet it also soon lost it; whereas, on its pivot and foot of sealing-wax, it retained it in damp weather for hours. This appears to depend on a portion of electricity, which, when the needle is first charged, passes on to the surface of the sealing-wax, and remaining there for awhile gradually returns to the needle, as its state is reduced by the action of the moist air, and supports, as it were, its electricity at a higher tension than it otherwise would have. M. Haüy expresses this by saying that the sealing-wax has the power both of conducting and insulating; by the first it receives a part of the electricity given to the needle, by the second it retains it, and then by the first it gives it back again to the needle when the air has taken away its own portion. The evident conclusion from the experiments are, that the apparatus is always ready for use, and will act in any weather.—*Journal de Physique*. P. 89, p. 455.

11. *Illumination by Electricity.*—Professor Meinecke of Halle has, in *Gilbert's Annals*, 1819, No. 5, proposed to illuminate halls, houses, and streets by the electric spark, and expresses his strong persuasion that one day it will afford a more perfect and less expensive light than gas-illumination, and ultimately replace it. His plan is, to arrange, what are called in electricity luminous tubes, glasses, *&c.*; *i. e.*, insulating substances, having a series of metallic spangles at small distances from each other, along the place to be illuminated; and then by a machine send a current of electricity through them: sometimes also partially exhausted glasses, as the luminous receiver, conductor, *&c.*, are

used. In this way Professor Meinicke obtained from a two feet plate machine a constant light in his apartment equal to that of the moon, and even surpassing it; and by enclosing his system of sparks in tubes filled with rarefied hydrogen gas, in which gas it is assumed that the electric spark is more than doubled in brilliancy, thinks it will be easy to enlarge the plan to any extent.

11. *Meteorology.*

[The very beautiful tables, accompanying this communication, we have been obliged to omit, in consequence of the space which they would occupy.]

SIR—You will herewith receive a Meteorological Map of the year 1819, containing the altitude of the barometer every day at noon, accompanied with a register of the thermometer, and wind at the same time; in addition to the map I have subjoined the following remarks on the whole year, which, should you consider worthy of a place in the Journals of the Royal Institution, are much at your service.

I am, Sir, respectfully yours, *&c.*,

JOHN LEWTHWAITE.

Rotherhithe, February 12, 1820.

1819. Months.	Mean of the Barometer at Noon.	Mean of the Thermometer at Noon.
	In. Dec.	
January	29,911	45°
February	29,794	45
March..........	30,027	49
April	29,932	56
May	30,024	64
June	30,048	66
July	30,122	72
August	30,150	74
September	30,118	66
October	29,973	57
November	29,889	46
December	29,877	41
Mean of the year	29,98875	56¾

	In. Dec.
Barometer's greatest observed altitude was on September 21st	30,600
Barometer's least observed altitude was on February 21st	29,262
Thermometer's maximum at *noon* was, on the 30th and 31st July, and 1st August, each day	82° Fahr.
Thermometer's minimum at *noon*, was on 11th of December	29 Fahr.
Thermometer's minimum was, on the night of the 10th and 11th December	13 Fahr.

13. *Aurora Borealis.*—A very fine aurora borealis was seen from Flensburg, in Sweden, at eight o'clock in the evening, on the 7th of October. The rays of light were very strong and luminous, ascending to the zenith. The light diminished in intensity from the bottom and the middle of the rays to the top and the sides.

IV. General Literature.

1. *Antique Silver Cup in America.*—There is now in the possession of Mr. Samuel Hill, of St. Clair County, Illinois, a silver cup, which was taken from one of the mounds at Marietta, on the Ohio. It is in the form of an inverted cone, measuring three and a half inches across at the top, two and a half at the bottom, and four inches in height. It appears to be of pure silver, and so skilfully wrought that no traces of the plating hammer are discernible. The bottom, which is circular, has been separately forged, accurately fitted to the sides or barrel of the cup, and soldered in, and the line of attachment is plainly observable. Its interior surface has been gilt, or washed, with a bright yellow untarnishable metal, which is undoubtedly gold, but the gilding is impaired in some places, and the vessel appears to have been considerably used.

" I am further enabled to state, from a conversation with Mr. Hill, that the cup was found in a mound, at Marietta, half a mile east of those remarkable ancient fortifications, on the Muskingum, which have attracted the notice and the wonder

of travellers, since the earliest settlement of the country. The mound is situated on a woody plain, with a gentle declivity towards the river, and a small stream washes its base, and, during the autumnal rains, or the melting of the snow in spring, runs with the velocity of a torrent. Thus it has gradually washed away the earth, and laid open the mound for a considerable space, and in this situation the cup was noticed by the discoverer. It was then in a bruised and shapeless mass, but being taken to a silversmith, was put into the shape it now presents, which is probably the shape it originally had. It bears no device or ornamental mark of any kind, being a perfectly plain heavy piece of workmanship."—*Schoolcraft Lead Mines, &c.* p. 276.

2. *University of Bonne.*—This institution, which has lately been founded by the King of Prussia, and endowed in the most liberal manner, is situated at Bonne, on the banks of the Rhine, between Cologne and Coblentz. The immense château of Bonne, *ci-devant* residence of the Elector of Cologne, is appropriated to the university; and the fine château of Poppledorf, with its plantations, are to be the botanical gardens. A large astronomical observatory will be immediately erected. Many libraries have been acquired by purchase and donations. The anatomical theatre, the medical and surgical hospitals, and the institution for midwifery; the cabinet of physic, the laboratory, the museum of natural history, of antiquities, of Roman and German coins, medals and monuments, found in the environs of Bonne; the Bonna Castra of the Romans, are already, or will soon be, completed.

There are at present forty-five Professors placed in the University by the King of Prussia, and there is place for ten more at least. The body of the University is composed of five faculties. The faculty of Theology, at present, possesses, for the Evangelical or Lutheran Confession, the Professors Augusti, Lücke, Sack, and Gieseler; for the Catholic Confession, the Professors Seber and Gratz; several more Professors for this faculty are expected. The faculty of Jurisprudence is composed

by the Professors Mittermaier, Welcker, jun., and Makeldey; to which are joined the Doctors in Law Burchardi, Walter, and Bermuth; the Professors of the faculty of Medicine are Harles, De Walter, Mayer, Stein, Windischmann Naste, Bischoff, and Dr. Weber.

For the different branches of Natural History there are Kastner, Nies, d'Esenbeck, and his brother Goldfus, Nœggerath, Bischoff, and Dalton; for Mathematics, Diesterweg; and for Astronomy, Munchen; for Metaphysics and Philosophy in general, besides the above, Windischmann, Delbruck, Welcker, sen., Von Calker, and Steingass.

In History, Hüllman and Arnolt; for Poetry, De Schlegel; for the Ancient and Oriental Languages, Heinrich, Naecke, Welcker, sen., Freitag; for the Modern Languages, Radloff, Freudenfeld, and Strahl; for Painting, Raabe, *&c.*

There were at Bonne, during the summer of 1819, more than 200 students.

3. *Lancasterian Schools.*—The Lancasterian method of instruction appears to be rapidly spreading over every part of Europe. In Spain, a royal decree has authorized the erection of a central school at Madrid, and others in the various communes of the kingdom. They are given in charge to the Minister of Justice and seven grandees; and the tribunals and civil and religious corporations are forbidden to interfere with them. In Portugal the system is carried on still more energetically, and many of the pupils are soldiers in the army. In Denmark a commission has been appointed to examine the method, and have delivered in a report. There appears to be much opposition to it amongst the Danish clergy; but the feeling is generally for it, and there is little doubt of its ultimate establishment and extension. On the 21st of August, the Lancasterian school of Copenhagen contained 162 scholars.

4. *Schools in Paris.*—A report has lately been made to the Society of Education at Paris, by M. Jarnard, from which it appears, that the number of schools already established, for boys is 41, and for girls 22. These schools are capable of

affording accommodation to about 6,600 scholars. The whole number of schools in France is said to be upwards of 1,000, of which 360 are included in M. Jarnard's report; of these 45 are instituted for girls, and the whole of them might instruct 40,600 scholars, or about 115 per school. On July 1, 1818, there were under instruction 19,175 children. There is also another description of schools, established by the "Brethren of the Christian Faith." These, in the course of three years, have increased from 60 to 142; and in the year 1818, they had 25,000 pupils.

5. *Comparative Strength of Europeans and Savages.*—M. Peron, the naturalist, has had occasion to observe, that men in a savage state are inferior in strength to men civilized; and has demonstrated in an evident manner, that the improvement of social order does not, as some have pretended, diminish our physical powers. The following are the results of some experiments made with the dynamometer of M. Regnier.

		Force with hands,	with traces.
Savages	Of Diemen's Land	50.6	0.0
	— New Holland	51.8	14.8
	— Timor	58.7	16.2
Europeans	French	69.2	22.1
	English	71.4	23.8

6. *State of the Population of Paris for* 1818.

BIRTHS.

At home	legitimate	boys	7,352	14,499
		girls	7,147	
	illegitimate	boys	2,158	4,201
		girls	2,043	
At the hospitals	legitimate	boys	265	479
		girls	214	
	illegitimate	boys	1,977	3,888
		girls	1,911	
Total of births		boys	11,752	23,067
		girls	11,315	
Natural Children	acknowledged	boys	1,069	8,089
		girls	935	
	abandoned	boys	3,066	
		girls	3,019	

DEATHS.

At home	males 6,234		
	females 7,169		
At the hospital	males 3,738		
	females 4,372		
French military	564		22,421
In prison	males 43		
	females 55		
Deposited at the Morgue	males 191		
	females 55		

MARRIAGES.

Bachelors and maids	5,476	6,616
Bachelors and widows	312	
Widowers and maids	625	
Widowers and widows	203	

DEATHS ACCORDING TO THE AGES.

Under 3 months	2,750	From 30 to 35 years	834
From 3 to 6 months	390	—— 35 to 40	815
—— 6 months to 1 year	793	—— 40 to 45	798
—— 1 to 2 years	1,634	—— 45 to 50	847
—— 2 to 3	903	—— 50 to 55	873
—— 3 to 4	526	—— 55 to 60	1,011
—— 4 to 5	325	—— 60 to 65	1,234
—— 5 to 6	278	—— 65 to 70	1,186
—— 6 to 7	244	—— 70 to 75	1,119
—— 7 to 8	144	—— 75 to 80	921
—— 8 to 9	120	—— 80 to 85	921
—— 9 to 10	116	—— 85 to 90	243
—— 10 to 15	462	—— 90 to 95	58
—— 15 to 20	855	—— 95 to 100	9
—— 20 to 25	1,200	Above 100	3
—— 25 to 30	880	Morgue	246

See vol. 7. p. 197.—*Annales de Chimie*, xii. p. 436.

7. *Death of Dr. Rutherford.*—In December last died Daniel Rutherford, M.D., Professor of Botany in the University of Edinburgh. He was the discoverer of nitrogen, which was first desribed by him in his *Thesis de Aere Mephitico*, in 1772.

8. *Petrarch.*—The following memorandum, written by Petrarch in a copy of Virgil, discovered in the Ambrosian Library at Milan, has been sent us by a friend lately returned from Italy :—

" Laura, propriis virtutibus illustris, et meis longum cele-

brata carminibus, primum oculis meis apparuit sub primum adolescentiæ meæ tempus, anno Domini 1327 die 6 mensis Aprilis in Ecclesia Sanctæ Claræ Avinioni hora matutina. Et in eadem Civitate, eodem mense Aprilis, eodem die 6, eadem hora prima, anno autem Domini 1348 ab hac luce lux illa subtracta est; cum ego forte Veronæ essem, heu fati mei nescius! Rumor autem infelix per literas Ludovici mei me Parmœ reperit anno eodem, mense Maji. die 19 mane.

"Corpus illud castissimum, ac pulcherrimum in loco Fratrum Minorum repositum est ipsa die mortis ad vesperam. Animam quidem ejus, ut de Africano ait Seneca, in cœlum, unde erat, rediisse mihi persuadeo.

"Hæc autem ad acerbam rei memoriam amara quadam dulcedine scribere visum est hoc potissimum loco qui sæpe sub oculis meis redit, ut cogitem nihil esse debere quod amplius mihi placeat in hac vita, et effracto majori laqueo, tempus esse de Babylone fugiendi, crebra horum inspectione, ac fugacissimæ ætatis æstimatione commonear. Quod, prævia Dei gratia, facile erit præteriti temporis curas supervacuas, spes inanes, et inexpectatos exitus acriter ac viriliter cogitanti."

9. *Bristol Literary and Philosophical Institution.*—On the 29th of February, the ceremony of laying the foundation-stone of a new and magnificent building, for literary and philosophical purposes in Bristol, was attended by the Right Worshipful the Mayor W. Fripp, jun., Esq., the sheriffs, and a numerous assemblage of gentlemen, some of the most distinguished for wealth and talent in Bristol. The company met their worthy chief magistrate at the Council-house, and thence proceeded in procession, with a band of music and the insignia of the city, to the ground; and afterwards returned in a similar order to the Merchant's Hall to dinner, where they spent the evening in the greatest harmony and unanimity.

The site of this building is at the west end of the bottom of Park-street, one of the finest streets in Bristol. It is intended for the building to contain a spacious lecture-room, with a laboratory adjoining; a room of noble dimensions destined for a library; two apartments which may be appropriated, the one for an exhibition room, the other for a museum; a reading-room for reviews, pamphlets, newspapers, *&c.*; some other apartment for subsidiary purposes, and the accommodation of a resident guardian of the building.

It has been for several years in contemplation to form a

Philosophical Society in Bristol after the example of London, Edinburgh, Liverpool, Dublin, and some other great towns of the empire; but, from the intervention of some cause or other, circumstances have continually occurred to delay the execution of so desirable an object. There is now, however, but little doubt, from the zeal which is manifested by the inhabitants of Bristol, for adding so useful an institution to the city and so great an ornament to its taste and opulence; that what the friends of this institution have been so long, so sedulously, and so laudably endeavouring to effect, will be attended with the completest success. It is unnecessary to enter into a detail of the advantages to society, commerce, and the arts, which have uniformly been derived in other places from establishments of this kind; they are too familiar to every well-informed mind to need any comment or observation. Justice, however, requires it should be known, that the patrons of this institution have formed their plans upon the broadest basis of enlightened liberality. Besides the cultivation and diffusion of the nobler sciences, and the prosecution of whatever is likely to be of real benefit or utility to the community and the rising generation, they intend to make this institution a focus, in which to collect and concentrate, not only the scattered rays of genius and ability of Bristol, but also of all true lovers of scientific pursuits; to confine their patronage to no particular branch or branches of science, but to extend and afford the utmost encouragement for the development of talent, in every department of useful knowledge and literature.

10. *Liverpool Museum*—A public museum of natural history has recently been attached to the Royal Liverpool Institution, and which was opened to the proprietors and strangers on the 1st of the new year. The opulence of that town, and the extensive intercourse it is hourly carrying on with all quarters of the globe, have long excited surprise that a public repository for the productions of distant countries has not been sooner established; it is, however, expected that the liberality of its inhabitants and of the friends of science will soon increase the foundation now laid of such a laudable undertaking, as many

valuable donations have already been received. The zoological part (filling two commodious rooms,) is systematically arranged with reference to the modern discoveries and improvements, by Mr. William Swainson, F.L.S., who has superintended the whole. The collection of *Zoophytes* are uncommonly fine, and are arranged after the admirable system of Lamark.

The gallery of pictures and sculpture has likewise been enriched by a fine series of casts from the Phygalean marbles, deposited there by John Foster, jun., Esq., well known as the companion of Mr. Cockerell, while prosecuting those interesting researches in Greece which led to their discovery. An academy of painting is immediately to be established.

11. *Observations on Bats.*—The individuals composing the genus *Vespertilio* or bat of Linnæus, (which, by modern authors, have very properly been subdivided into several distinct genera,) are well known to derive their sustenance from animal juices; but the observations of Mr. Swainson on these animals, during his travels in Brazil, prove that several species are equally fond of vegetable food. He informs us, that while residing at a plantation in the province of Pernambuco, he was particularly struck by the great numbers of these animals that were constantly seen at twilight flying with a rapid and heedless course among a group of fig-trees that were in the garden attached to the house; on observing it to his host, he was assured that they were considered the greatest pest to the grounds as destroying the fruit the moment it reached any maturity, and in fact such trees as were in the fullest bearing were covered with nets. Anxious to ascertain this fact, Mr. Swainson spread a small quantity of birdlime on these nets, and by this means procured several specimens, which, on dissection, were found to contain part of the undigested fruit. He subsequently found many others, which, by entangling themselves in the meshes thus prepared, were easily captured in the morning. Mr. Swainson believes that the formidable *Vespertilio Vampyrus,* Linn., and other larger bats of Guiana, and the adjacent provinces, are unknown in the southern parts of Brazil, No. of lat. 8.12′.

12. *On the Use of Oxen in Agriculture.*—Sir, In the *Quarterly Journal* for April 1819, is a letter signed C., suggesting the possibility of moving ploughs, *&c.*, by wind or steam. Now it appears to me to be a matter of much less public benefit than working them generally with oxen. It is uncertain whether we may ever arrive by the one at any useful purpose, but the good effects of the other are certain. I have always thought taking off the tax on farm-horses a very unadvised step. The true policy would be to put on a heavy addition, and thus to compel the use of oxen. Their keep is cheaper than that of horses; and when worked for three or four years they will sell for more than prime cost, and coming into our markets furnish food for thousands. Our horses used in husbandry are estimated at 1,200,000; if oxen supplied the place of one half, namely, of 600,000, and these were to come off to the butcher when seven years old, we should have about 100,000 every year entering our markets, which is nearly or quite equal to the annual consumption of London. Large oxen of the Holderness breed might be used to great advantage. The beef of these animals in full health and exercise must be finer flavoured than that of oxen eating oil-cake, tied up by the neck without motion for three months, or confined in a little dirty, miry yard, about twice as large as themselves.

Another useful invention is much to be desired, namely, a cheap fishing-net, so constructed as to resist the teeth of the dog-fish, with which our sea swarms. They not only prey upon valuable fish to an incredible degree, but often ruin the fisherman for the season. It is no uncommon circumstance for many of these creatures, when inclosed in a new net, to bite their way through and destroy it. To say nothing of the fish they destroy, the mischief they do to the nets exceeds belief. If caught, they would make excellent manure. To this fishery let another be added, for the porpoise, because they are known to live upon salmon, and chase them as a hound does a hare. From these oil might be made. Both these fisheries would employ hundreds of the starving sailors; rid our seas, in time, of these destroying animals; and fill our barns with plenty, from the fine manure they would furnish. D.

Art. XVII. METEOROLOGICAL DIARY for the Months of December 1819, and January, and February, 1820, kept at Earl Spencer's Seat at Althorp, in Northamptonshire. The Thermometer hangs in a North-eastern Aspect, about five feet from the ground, and a foot from the wall.

For December, 1819.

		Thermometer Low	Thermometer High	Barometer Morn.	Barometer Eve.	Wind Morn.	Wind Eve.
Wednesday	1	45	46	29,40	29,82	S	WbS
Thursday	2	33	47	29,78	29,78	SW	SW
Friday	3	26	40	29,94	29,98	W	WbS
Saturday	4	29	45	29,56	29,41	S	NE
Sunday	5	38	39	29,83	29,85	NE	NE
Monday	6	35	37	29,90	29,91	NE	NE
Tuesday	7	34	33	29,91	29,89	NE	NE
Wednesday	8	28	29	29,89	29,89	NE	NE
Thursday	9	20	26,5	29,95	29,95	NE	NE
Friday	10	25	29	29,82	29,82	N	NNW
Saturday	11	14	28	29,85	29,85	WbN	WbS
Sunday	12	23	35	29,80	29,80	W	W
Monday	13	24	32,5	29,77	29,64	W	WbN
Tuesday	14	23	34	29,60	29,40	WbS	SW
Wednesday	15	29	37	29,27	29,33	W	W
Thursday	16	32	35	29,63	29,80	W	SW
Friday	17	28	43	29,50	29,20	SE	SE
Saturday	18	40	50	29,18	29,37	WbS	WbS
Sunday	19	45	52	29,61	29,54	SW	SW
Monday	20	49	52,5	29,49	29,47	WbS	WbS
Tuesday	21	41	47	29,78	29,62	W	EbS
Wednesday	22	39	48	29,48	29,57	SW	WbN
Thursday	23	40	39	29,16	29,20	WbN	NW
Friday	24	30	33,5	29,22	29,21	W	SW
Saturday	25	27	31	29,30	29,30	NW	WbN
Sunday	26	21	30	29,37	29,37	WbS	SSW
Monday	27	24	31,5	29,36	29,38	E	ENE
Tuesday	28	26,5	32	29,40	29,44	NE	NE
Wednesday	29	25	29	29,50	29,50	N	W
Thursday	30	22	33	29,40	29,29	WbS	S
Friday	31	24	34	29,22	29,20	S	SW

For January, 1820.

		Thermometer Low	Thermometer High	Barometer Morn.	Barometer Eve.	Wind Morn.	Wind Eve.
Saturday	1	20	30	29,31	29,40	WbS	WbS
Sunday	2	19	35	29,47	29,34	W	S
Monday	3	27	27	29,40	29,71	NW	W
Tuesday	4	8	22	29,91	29,91	W	W
Wednesday	5	4	27	29,98	29,98	W	WSW
Thursday	6	26	35,5	29,95	29,99	W	WbN
Friday	7	33	32,5	30,10	30,30	E	ENE
Saturday	8	21	28	30,11	30,50	NE	NE
Sunday	9	19	32	30,60	30,40	NE	NE
Monday	10	25	33	30,29	30,19	ENE	N
Tuesday	11	29	36	29,89	29,62	NW	N
Wednesday	12	28	27	29,84	30,08	E	E
Thursday	13	14	29	30,02	30,02	WbN	E
Friday	14	19	27	30,09	30,03	ENE	ENE
Saturday	15	9	26	29,73	29,60	W	W
Sunday	16	20	27	29,60	29,60	W	W
Monday	17	16	33	29,50	29,40	W	SSW
Tuesday	18	28	31	29,34	29,13	NE	EbN
Wednesday	19	30	41,5	28,67	28,85	WbS	NNW
Thursday	20	23	31	29,39	29,28	WbN	E
Friday	21	28	32	29,08	29,47	ENE	NNE
Saturday	22	11	23	29,87	30,00	NW	WNW
Sunday	23	5	37	29,90	29,84	S	SE
Monday	24	35	40	29,62	29,51	S	S
Tuesday	25	38	41	29,70	29,48	S	SSE
Wednesday	26	39	46	29,28	29,46	WbS	WbS
Thursday	27	41	47	29,39	29,28	WbS	SW
Friday	28	40	43	29,41	29,84	NW	N
Saturday	29	33	41	30,00	30,00	W	SW
Sunday	30	34	45	29,90	29,90	W	S
Monday	31	39	44	29,83	29,83	SW	SW

For February, 1820.

		Thermometer Low	Thermometer High	Barometer Morn.	Barometer Eve.	Wind Morn.	Wind Eve.
Tuesday	1	35	42	29,84	29,76	SW	SE
Wednesday	2	26	37	29,70	29,75	SE	ESE
Thursday	3	30	43	29,80	29,88	ESE	NE
Friday	4	31	37	29,90	29,89	NE	SE
Saturday	5	35	48	29,80	29,71	SE	SSW
Sunday	6	38	46	29,68	29,80	SE	SW
Monday	7	40	52	29,90	29,94	SW	WSW
Tuesday	8	45	49	29,94	29,97	SW	SW
Wednesday	9	43	48	29,90	29,76	SW	SW
Thursday	10	40	45,5	29,70	29,86	SW	WbN
Friday	11	31	46,5	29,94	29,80	SW	S
Saturday	12	40	44	29,70	29,87	W	NE
Sunday	13	38	42,5	29,90	29,90	SE	SE
Monday	14	31	43	30,06	30,10	SW	N
Tuesday	15	29	35	30,18	30,20	N	NE
Wednesday	16	30	33	30,18	30,10	SE	E
Thursday	17	20	34	30,00	29,96	E	SE
Friday	18	15	33	29,98	29,98	SE	E
Saturday	19	25	37	30,00	29,99	NE	NE
Sunday	20	30	35	29,81	29,80	N	NE
Monday	21	28	36	29,70	29,73	NE	NE
Tuesday	22	33	40	29,70	29,68	NW	NE
Wednesday	23	35	45	29,47	29,40	NE	SW
Thursday	24	36	38	29,32	29,30	WbS	NW
Friday	25	33	40	29,40	29,60	N	N
Saturday	26	33	35	29,86	30,00	NE	NE
Sunday	27	28	37	30,03	30,03	NE	NE
Monday	28	22	38	29,95	29,82	NE	NE
Tuesday	29	18,5	41	29,78	29,57	NE	WbS

SELECT LIST OF NEW PUBLICATIONS,

DURING THE LAST THREE MONTHS.

Agriculture, Botany, and Rural Economy.

The Farmer's and Land Steward's Assistant, or a Specimen of Farm Book-keeping; exhibiting, in a concise and simple form, the Transactions in the Arable, Growing, and Woodland Departments, a general Cash Account, and Account of the Charge and Discharges upon each Department; the whole selected from Books of real Business. By J. Mather. 4to., 10*s.* 6*d.*

A Treatise on the Management of Hedges and Hedge-row Timber. By Francis Blaikie. 12mo., 2*s.*

Observations on the Structure of Fruits and Seeds. By John Lindley. 8vo., 5*s.* 6*d.*

A New System of Cultivation, without Lime, Dung, or Summer Fallows. By Maj.-Gen. Alex. Beatson. 8vo., with plates, 9*s.*

Lithography.

A Manual of Lithography. By C. Hullmandel. 8vo. 6*s.*

Mechanics.

An Elementary Treatise on Mechanics, Vol. I., containing Statics and part of Mechanics. By W. Whevell, 8vo., 15*s.*

An Analytical Essay on the Construction of Machines. Illustrated by thirteen lithographic plates. 4to., 18*s.*

Medicine, Anatomy, and Surgery.

Opinions on the Causes and Effects of Diseases in the Teeth and Gums. By C. Bew. 8vo., 1*l.* 1*s.*

A Compendium of Anatomy, Human and Comparative, for the use of Students. By A. Fyfe, M.D. A new edition, greatly enlarged and improved. 4 vols. 8vo., 2*l.* 2*s.*

Observations on the Use and Abuse of Mercurial Medicines in various Diseases. By J. Hamilton, jun. M.D. 8vo 7*s.* 6*d.*

A General Index to the London Medical and Physical Journal; comprising an Analytical Table of the Contents of the first Forty Volumes of that Work. 8vo. 1*l.* 1*s.*

An Inquiry, illustrating the Nature of Tuberculated Accretions of Serous Membranes, *&c.* By John Baron. 8vo. 14*s.*

The Dublin Hospital Reports, and Communications in Medicine and Surgery. Vol. II. 8vo. 13*s.*

Observations on the Nature and Cure of Cancer, and on the too frequent Use of Mercury. By Charles Aldis. 8vo., 4*s.* 6*d.*

The Morbid Anatomy of the Liver. By J. R. Farre. Parts I. II., with coloured plates, 15*s.* each.

Pathological Researches in Medicine and Surgery. By J. R. Farre. Part I., with plates, royal 8vo., 7*s.*

The Mother's Medical Assistant; containing Instructions for

the Prevention and Treatment of the Diseases of Infants and Children. By Sir Arthur Clarke. 8vo., 4*s.* 6*d.*

Letters on the Disorders of the Chest, *&c.*, 3*s.*

General Indications which relate to the Laws of Organic Life. By Dan. Pring, 8vo., 12*s.*

An Essay on Phrenology; or an Inquiry into the Principles and Utility of the System of Drs. Gall and Spurzheim. By G. Combe. 8vo., 12*s.*

An Account of the Varioloid Epidemic, which has lately prevailed in Edinburgh and other parts of Scotland, with Observations on the identity of Chicken Pox with modified Small Pox, in a Letter to Sir James M'Gregor. With a copious Appendix of interesting Documents. By John Thomson, M.D., F.R.S.E., 8vo. 10*s.* 6*d.*

Practical Observations on the Means of Preserving the Health of Soldiers in Camp and in Quarters. With Notes on the Medical Treatment of several of the most Important Diseases which were found to prevail in the British Army during the late War. By Ed. Thornhill Luscombe, M.D. 8vo. 6*s.*

The Principles of Military Surgery, comprising Observations on the Arrangement, Police, and Practice of Military Hospitals; and on the History, Anomalies, and Treatment of Syphilis and Varioli. Illustrated by Cases, Dissections, and Engravings. By John Hennen, M.D. Second edition. 8vo. With Engravings.

Tic Douleureux; a Treatise on this excruciating Disease of the Face; with Practical Observations, tending to promote a Plan of Prevention and radical Cure. By an Army Surgeon. 8vo., 7*s.* 6*d.*

Mineralogy and Geology.

A Selection of Facts from the best Authorities, arranged so as to form an Outline of the Geology of England and Wales; with a coloured Map, and Sections of the Strata. By Wm. Phillips, F.L.S. 8vo. 9*s.*

A System of Mineralogy. By Robert Jameson, Professor of Natural History in the University of Edinburgh. 3 vols. 8vo. A new edition. With numerous Plates. 2*l.* 16*s.*

A New Geological Atlas of England and Wales, Part II., containing Maps of the Counties of Gloucester, Surrey, Suffolk, and Berks. By Wm. Smith. 1*l.* 1*s.*

Miscellaneous.

The Encyclopædia Britannica; or, Dictionary of Arts, Sciences, and Miscellaneous Literature. Sixth edition. Corrected, improved, and enlarged. Vol. I. Part I. 16*s.*

Supplement to the Encyclopædia Britannica. Edited by Macvey Napier, F.R.S. Vol. IV. Part I. 1*l.* 5*s.*

A Treatise on the Adulterations of Food and Culinary Poisons. By Frederick Accum, M.R.I.A. 12mo. 9*s.*

Rules proposed for the Government of Gaols, Houses of Cor-

rection, and Penitentiaries; to which are added, Plans of Prisons on improved principles, *&c.*, *&c.* By the Society for improvement of Prison Discipline; and for the Reformation of Juvenile Offenders. 8vo. 9*s.*

Natural History and Natural Philosophy.

Horæ Entomologicæ: or Essays on the Annulose Animals. By W. S. Macleay. Vol. I., part 1, 8vo., with plates, 12*s.*

A Dictionary of Natural History, or a complete Summary of Zoology. With plates, 9*s.* plain, 12*s.* coloured.

A Commentary on the Systems, which have been advanced for explaining the Planetary Motions. By James Burney, Esq., R.N., 8vo., 2*s.* 6*d.*

Dialogues on Entomology; in which the Forms and Habits of Insects are familiarly explained. 12mo. with 25 plates, 12*s.* plain, 18*s.* coloured.

Topography.

The History and Topography of the Parish of Sheffield, in the County of York. By Joseph Hunter. 4to. 4*l.* 4*s.*

History and Antiquities of the Metropolitan Church at York. By John Britton. With 35 plates. Medium 4to. 3*l.* 15*s.* Imperial 4to., 6*l.* 6*s.* Crown folio, 10*l.* 10*s.* Royal folio, 12*l.* 12*s.*

Dr. Whittaker's History of Yorkshire, Part III., 2*l.* 2*s.*

An Account of the Ancient and Modern State of the City and Close of Lichfield. 8vo., 5*s.*

An Original History of the City of Gloucester, almost all compiled from New Materials; including the Original Papers of the late Ralph Bigland, Esq. By the Rev. T. D. Fosbrooke, M.A. 4to., 3*l.* 3*s.*

The Rise and Progress of the City of Glasgow, comprising an Account of the Public Buildings, Charities, *&c.* By James Cleland. 8vo., 7*s.* 6*d.*

An Historical Map of Palestine, or the Holy Land, 40 inches by 27¼; exhibiting a correct Delineation of the peculiar Geographical Features of the country, and those names of places which accord with the Scripture Narrative. 1*l.* 8*s.* Mounted on Canvass, with a Roller, 1*l.* 15*s.*

Leigh's New Picture of England and Wales, comprising a Description of the Principal Towns, Ancient Remains, Natural and Artificial Curiosities, Soil and Produce, Agriculure, Manufactures, Rivers and Canals, Principal Country Seats, and Bathing Places; together with Historical and Biographical Notices, Synopsis of the Counties, &c. Embellished with numerous Views and an Accurate Map. 18mo., price 12*s.* bds., or 13*s.* bound.

Leigh's New and Correct Pocket Atlas of England and Wales, consisting of Fifty-five County Maps, and a General Map. Intended to form a Companion to the New Picture of England and Wales. 18mo., 12*s.* half-bound.

Scenery and Antiquities of Mid-Lothian. Drawn and etched by an Amateur. 4to. 1*l.* 1*s.*

Boydell's Picturesque Scenery at Norway, No. VIII. 3*l.* 3*s.*

Delineations of Pompeii. Part II. Imperial folio. 4*l.* 4*s.*

Views in Greece, from original Drawings. By E. Dodwell, Esq. F.S.A. Part IV. Imperial folio.

Peak Scenery. By E. Rhodes. With Engravings, by G. Cooke. Part II. 4to. 1*l.* 1s.

Ackermann's Tour of the Rhine. Part II. 4to. 1*l.* 4*s.*

Views at Hastings and its Vicinity, from splendid Drawings. By J. M. W. Turner, R.A. Part I. Super-royal folio, 3*l.*

Voyages and Travels.

Travels in Nubia and in the Interior of Eastern Africa. By J. L. Burchardt. With a Life and Portrait of Author. 4to. 48*s.*

An Account of the Arctic Regions, including the Natural History of Spitzbergen and the adjacent Islands ; the Polar Ice, and the Greenland Seas; with a History and Description of the Northern Whale Fishery. Chiefly derived from Researches made during Seventeen Voyages to the Polar Seas. By William Scoresby, jun. F.R.S.E. 2 vols. 8vo. 24 Engravings. 42*s.*

Travels in the North of Germany, describing the present State of the Social and Political Institutions, the Agriculture, Manufactures, Commerce, Education, Arts, and Manners of that Country, particularly the Kingdom of Hanover. By Thomas Hodgskin, Esq. 2 vols. 8vo. 1*l.* 4*s.* boards.

Travels in Italy, Greece, and the Ionian Islands, in a Series of Letters, descriptive of Manners, Scenery, and the Fine Arts. By H. W. Williams, Esq. 2 vols. 8vo., with 20 Engravings. 42*s.*

The Traveller's Fireside; a Series of Papers on Switzerland, the Alps, *&c.* By S. M. Waring. 12mo. 5*s.* 6*d.*

A Journey in Carniola and Italy, in the Years 1817-1818. By W. A. Cadell, Esq. F.R.S. 2 vols. 8vo. With 33 Engravings. 1*l.* 16*s.* boards.

Travels in various Countries in the East, more particularly Persia, in 1810, 1811, and 1812. By Sir Wm. Ouseley, L.L.D., *&c. &c.*, Private Secretary to Sir Gore Ouseley, Bt. 4to. 3*l.* 3*s.*

A Voyage to South America, performed by order of the American Government, in the Frigate Congress. By H. M. Brackenridge, Esq., Secretary to the Mission. 2 vols. 8vo. 1*l.* 4*s.*

Travels in the Interior of Africa, to the Sources of the Senegal and Gambia, undertaken by order of the French Government, and performed in 1818. By M. G. Mollien, edited by T. E. Bowdich, Esq., conductor of the Mission to Ashantee. 4to. with Map and Plates. 2*l.* 2*s.*

A Voyage to India. By the Rev. Jas. Cordiner, A.M. 8vo, 7*s.*

An Historical and Statistical Account of the Principalities of Wallachia and Moldavia. By Wm. Wilkinson, Esq., late his Britannic Majesty's Consul to those Principalities. 8vo, 9*s.*

Scientific French Works,

Recently imported by Messrs. Treuttel and Würtz.

Reynier, de l'Economie Rurale et Publique des Perses et Phéniciens. 8vo, 13*s.*

Borgnis, Traité complet de Mécanique, partie VI. des Machines employées à diverses fabrications. 4to., Fig. 1*l.* 14*s.*

Kluber, Droit des Gens Modernes de l'Europe. 8vo, 2 vols. 1*l.* 1*s.*

Millin, Description d'une Mosaïque Antique du Musée Pio-Clementin à Rome, representant des Scènes des Tragédies. Folio, *avec* 28 *plaoches.* 4*l.* 4*s.*

Dictionnaire des Sciences Médicales. Tom. 38 et 39, 8vo. 1*l.*

Victoires, Conquetes, *&c.*, des François. Tom. 16, 8vo. 11*s.*

Cuvier et Lasteyrie, Histoire Naturelle des Mammifères, Livraison 11. Folio, 6 *fig. color.* 1*l.* 1*s.*

Nouveau Dictionnaire d'Histoire Naturelle. Tom. 34, 35, 36, 8vo. 2*l.* 8*s.*

Le Même Ouvrage, complet, en 36 tomes. 28*l.* 16*s.*

De Gérando, Programme du Cours de Droit Public Positif et Administratif, à la Faculté de Droit de Paris, pour l'année 1819-20. 8vo, 3*s.* 6*d.*

Molien, Voyage dans l'Intèrieur de l'Afrique, aux Sources du Senegal et da Gambie, fait en 1818, par ordre du Governement Français; *avec carte et vues*, 2 vol. 8vo. 1*l.* 8*s.*

Annuaire Medico-Chirurgical des Hôpitaux et Hospices civils de Paris, ou Recueil de Mémoires et Observations, par les Médecins et Chirurgiens de ces Etablissemens. 4to, avec un Atlas in folio Atlantique de 15 *planches.*

Revue Médicale Historique et Philosophique. Par MM. V. Bally, Bellanger, F. Bérard, Bestien, Bousquet, Delpech, Desportes, Double, Dunal, Esquirol, Gasc, Giraudy, Jadioux, Laurent, Nicod, Prunelle, Rouzet. 1ère Année, 1ère Livraison, et Subscription à No. VI. inclusivement. 2*l.*

Cuvier, Histoire Naturelle des Mammifères, Livraison XI. e XII. Folio, *avec* 6 *fig. color.* each 1*l.* 1*s.*

Gall et Spurzheim, Anatomie et Physiologi du Systême Nerveux en Général et du Cerveau en Particulier. Tom. IV. 2de partie, in 4to, *avec* 17 *Planches in folio.* 4*l.* 4*s.*

Bordot, Instructions sur la Santé des Femmes enceintes, et sur les moyens de la conserver, *&c.* 8vo, 4*s.*

Montègre, des Hémorrhoïdes, ou Traite des toutes les Affections Hémorrhoïdales. 8vo, 8*s.*

Boniface, Cours Elémentaire et Pratique de Dessein d'après les Principes de Pestalozzi, suivis á Yverdun, sous la direction de M. Jn. Ramsauer, et publié avec de nombreuses modifications; *orné de* 4 *planches*, No. 1—4, in 4to, oblong, 1*l.*

THE

QUARTERLY JOURNAL,

July, 1820.

Art. I. *A Sketch of the History of Alchymy.* *By* W. T. Brande, Sec. R.S., *and* Prof. Chem. R.I.

THE materials composing the history of alchymy being scattered through a variety of obscure publications, many of which are scarce, and others not frequently found in our libraries, it is presumed that the following account of some of their principal contents may not be wholly unacceptable to our readers, more especially as they are frequently alluded to by the chemical writers of the sixteenth and seventeenth centuries, whose works may occasionally be consulted with advantage, though the authors they quote are scarcely worth the trouble of perusal.

The transmutation of baser metals into gold was not only regarded as possible, but believed to have been performed, by some of the more enlightened chemists of the seventeenth century; and in perusing the history of some of these transmutations, as recorded by Helvetius, Boerhaave, Boyle, and other sober-minded men, it would be impossible to resist the evidence adduced, without the aids of modern science. Lord Bacon's sound sense has been arraigned for his belief in alchymy, though he in fact rather urges the possibility than the probability of transmutation; and considering the infant state of the experimental sciences, and of chemistry in particular, in his age, and the plausible exterior of the phenomena that the chemists were able to produce, he is rather to be considered as sceptical than credulous, upon many of the points which he discusses.

Hermes Trismegistus has generally been quoted as the

oldest of the alchymists; there can, however be very little doubt that the writings attributed to him are entirely spurious. The *Tractatus Aureus*, or *Golden Work*, is evidently a farrago of occult philosophy belonging to a much later period. Hermes at the outset is made to apologize for divulging the secrets of the black art. "I should never have revealed them," says he, "had not the fear of eternal judgment, or the hazard of the perdition of my soul prevailed with me, for such a concealment. It is a debt I am willing to pay to the just, even as the Father of the just has liberally bestowed it upon me." After this prelude, we might expect to be let into some of the mysteries of alchymy, but our curiosity is quickly disappointed by finding that they are only revealed to the eyes and ears of the sons of art; "not to the profane, the unworthy, and the scoffers, who, being as greedy dogs, wolves and foxes, are not to feed at our divine repast." The reader is then conducted into what is termed the *innermost chamber*, and regaled with a history and explication of various matters relating to the philosopher's stone, by means of which "through the permission of the Omnipotent, the greatest disease is cured, and sorrow, distress, evil, and every hurtful thing evaded; by help of which we pass from darkness to light, from a desert and wilderness to a habitation and home, and from straightness and necessities to a large and ample estate." We are then directed "to catch the flying bird," by which is meant quicksilver; "and drown it so that it may fly no more;" this is what is afterwards termed the fixation of mercury, by uniting it to gold. It is then to be plunged into the "well of the philosophers," or aqua regia, "by which its soul will be dissipated, and its corporeal particles united to the red eagle," or muriate of gold.

We may, however, at once cut short these observations by remarking, that all the details bear upon increasing the weight of gold by the influence of mercury, and this imaginary document of Hermes will suffice as an example of all the earliest alchymical authors.

Geber is another great name in the history of alchymy; though the exact period at which he lived is unknown, it was

probably not later than the seventh century. His three books of alchymy were published at Strasburgh in 1520, and if genuine, of which there is much doubt, contain matter that well justifies the *eloge* of Boerhaave, who considers him as a first-rate philosopher of his age. In his chapter "on the Alchemie of Sol," after descanting upon the different means of refining and dissolving gold, he describes several solar medicines in language which is tolerably intelligible; they are all solutions of gold in nitro-muriatic acid, with the addition of quicksilver, nitre, common salt, and some other saline matters, and the student is directed to prepare his mind for their performance by suitable acts of piety and charity, which if earnestly and perseveringly carried on, may, after due time, enable him, in the language of his translator, Dr. Salmon, "to change argent vive into an infinite solific and lunific, without the help of any thing more than its multiplication." Alembics, crucibles, and various furnaces are so fully described, and if we may believe the MSS. depicted by Geber, that he deserves to be mentioned also as the inventor of much useful apparatus.

Artephius in 1130 published several alchymistical tracts; we are told by Roger Bacon and others, that he died at the advanced age of 1025, having prolonged his life by the miraculous virtues of his medicines; but his name, and that of John de Rupescissa, are now deservedly buried in oblivion.

The alchymical annals of the thirteenth century are adorned by the name of Roger Bacon, a native of Ilchester, in Somersetshire, and descended from an ancient and honourable family. In 1240, he returned from Paris, and became celebrated among the learned of the University of Oxford. At that time, however, the exposition of ignorance, and attempts to overthrow the dogmas of the schools, was a service of risk and danger; and to this Friar Bacon, for he was a monk of the Franciscan order, laid himself fully open; he was accused of practising witchcraft, thrown into prison, and nearly starved, for exposing the prevalent immorality of the clergy; and, according to some, stood a chance of being burned as a magician.

I know of no work that strikes one with more surprise and

admiration, than the *Opus Majus* of Roger Bacon; he stands alone like a beacon upon a waste; his expressions are perspicuous and comprehensive, such as betoken a rare and unclouded intellect; and they are full of anticipations of the advantages likely to be derived from that mode of investigation insisted upon by his great successor, Chancellor Bacon. This resemblance between Roger Bacon and his illustrious namesake, has scarcely been noticed by the historians of his period; it has, however, not escaped Mr. Hallam's observation, who adverts to it in his "History of the Middle Ages." Whether Lord Bacon he says, "ever read the *Opus Majus* I know not, but it is singular, that his favourite quaint expression, *prærogativæ scientiarum*, should be found in that work; and whoever reads the sixth part of the *Opus Majus*, upon experimental science, must be struck by it as the prototype in spirit of the *Novum Organum*. The same sanguine, and sometimes rash confidence in the effect of physical discoveries; the same fondness for experiment; the same preference of inductive to abstract reasoning pervade both works.

The alchymical work of Roger Bacon, that has been most prized, is the *Mirror of Alchymy*, but there is little either of interest or entertainment to be extracted from it.

Roger Bacon has by some been spoken of as a benefactor to mankind, by others as an enemy to the human race, inasmuch as he is plausibly considered to have invented gunpowder, an invention by which the personal barbarity of warfare has certainly been diminished, "but which considered as an instrument of human destruction, by far more powerful than any that skill had devised, or accident presented before; acquiring, as experience shews us, a more sanguinary dominion in every succeeding age, and borrowing all the progressive resources of science and civilization for the extermination of mankind, appals us," says a modern writer, "at the future prospects of the species, and makes us feel perhaps more than in any other instance, a difficulty in reconciling the mysterious dispensation with the benevolent order of Providence."

This discovery has sometimes been given to Bartholomew

SCHWARTZ, a German monk, and the date of 1320 annexed to it, a date posterior to that which may be justly claimed for Friar BACON. Upon the authority, however, of an Arabic writer in the Escurial collection referred to by Mr. HALLAM, there seems little reason to doubt that gunpowder was introduced through the means of the Saracens, into Europe, before the middle of the fifteenth century, though its use in engines of war was probably more like that of fireworks than artillery. Many authorities might be adduced to prove the common use of gunpowder early in the fourteenth century. EDWARD III. employed artillery with memorable effect, at the battle of Cressy, and in the fifteenth century hand-cannons and muskets came into use, and gun-powder was in common employ.

ALBERT OF COLOGNE, surnamed THE GREAT, was a contemporary of ROGER BACON; he is celebrated as the inventor of the brazen head which was demolished by the pious zeal of his pupil, the angelical Dr. AQUINAS, in consequence of his suspecting it to be an agent of the devil.

ALBERTUS MAGNUS was what in our days is termed an universal genius. He is chiefly celebrated as the commentator of ARISTOTLE; but, if we give credit to contemporary writers, he was deeply skilled in all the higher departments of alchymical philosophy.

The names of RAYMOND LULLY of Majorca, and ARNOLD OF VILLANOVA, occur in this page of the history of chemical science. Their merit, like that of many modern writers, consists rather in quantity than quality. LULLY died on his passage from Africa in 1315, whither he had been to preach the truths of the Gospel; his body was carried to Majorca, where he was honoured as a martyr. BRUCKER says, "he was more ingenious than honest." I have not thought his chemical opinions worth quotation or abstract. A specimen given in the *Biographical Dictionary* is ridiculous, from the transcriber having turned over two leaves instead of one, and curious from the narrative being quite as intelligible as if its thread had not been thus interrupted. This I presume will suffice for RAYMOND LULLY.

VILLANOVA shines as a magician and astrologer. He was a renowned prophet, and predicted that the world would come to an end in the year 1376. He was shipwrecked on the coast of Genoa, in 1313.

About the year 1560, a Treatise of Alchymy was published at Paris, attributed to NICHOLAS FLAMMEL. The work, however, is spurious, and was merely attributed to him from his becoming suddenly, as it is said, very rich. The use he made of his wealth does his memory much credit: he founded hospitals, repaired churches, and endowed several charitable institutions; proceedings which by no means savour of alchymy.

Dr. SALMON, who in 1692 published one of the above-mentioned tracts, says, "Flammel was originally a poor scrivener, yet left so great monuments behind him, as must convince the most incredulous that he knew the secret, and performed such mighty works at his own proper cost and charges, as the most opulent prince in Europe can never do the like. I know," says he, "a gentleman who went to view those mighty buildings and their records. The archives and governors of those places, he told me, own the matter of fact but deny the means, saying, that Flammel was a very pious man, and went a pilgrimage to St. James of Gallicia, for a reward of which piety the holy saint bestowed that vast treasure upon him by way of miracle; thereby denying the power of art by which it was certainly effected, to establish a miracle performed by the Romish Saint."

He was moreover celebrated for his hieroglyphics, of which fac-similes are given in SALMON's edition. They are much of the same cast as those that now adorn Moore's Almanack, and quite as edifying.

In SALMON's collection we find the "*Marrow of Alchymy* by GEORGE RIPLEY, Chanon of Bridlington in Yorkshire," who was a chemist perhaps less deserving of the reputation he acquired than most of his compeers. He may be quoted as a chemical poet. His *Compound of Alchemie*, dedicated to Edward IV., is rugged enough, but not unintelligible. The following stanzas from the preface of this piece, given in

ASHMOLES' *Theatrum Chemicum Brittanicum*, will afford a fair idea of Ripley's merits as a poet and philosopher:

> " But into Chapters thys Treatis I shall devyde,
> In number twelve, with dew recapytulatyon;
> Superfluous rehearsalls I lay asyde,
> Intendyng only to give trew informatyon,
> Both of the theoryke and practycall operatyon:
> That by my wrytyng who so wyll guyded be,
> Of hys intente perfyctly speed shall he.
>
> " The fyrst chapter shall be of naturall *Calcination;*
> The second of *Dyssolution*, secret and phylosophycall;
> The third of our elementall *Separation;*
> The fourth of *Conjunction* matrimoniall;
> The fyfth of *Putrefaction* then followe shall;
> Of Congelation *Albyficative* shall be the sixt,
> Then of *Cybation*, the seaventh, shall follow next.
>
> " The secret of our *Sublymation* the eyght shall show;
> The nynth shall be of *Fermentatyon;*
> The tenth of our *Exaltation* I trow.
> The elevent of our mervelose multiplycatyon,
> The twelfth of *Projection*, then *Recapitulatyon*,
> And so this treatise shall take an end,
> By the help of God, as I entend.
>
> " Thus here the Tract of Alchemy doth end;
> Which tract was by George Ripley, Chanon, penn'd.
> It was composed, writt, and signed his owne,
> In anno twice seaven hundred seaventy one.
> Reader, assist him, make it thy desire
> That after lyfe he may have gentle fire!
> AMEN."

The degree of faith placed in alchymy was of course much shaken by the multiplied experiments that were undertaken during the seventeenth century; in general, however, those who failed attributed their ill success to any rather than the real cause. Salmon's creed is that of most of his contemporaries. " As to the great and philosophic work," says he, (meaning transmutation,) " it is my opinion and belief that there is such a thing in nature. I know the matter of fact to be true, though the way and manner of doing it is as yet hid from me. I have been eye-witness of so much as is able to

convince any man endued with rational faculties, that there is a possibility of the transmutation of metals; yet for all these things, will not advise any man ignorant of the power of nature and the way of operation to attempt the work, lest erring in the foundation, he should suffer loss and blame me. Without doubt it is a gift of God from above, and he that attains it must patiently wait the moving of the waters; when the destined angel moves the waters of the pool, then is the time to immerge the leprous metal, and cleanse it from all impurities."

Vanhelmont says, "I am constrained to believe in the making of gold and silver, though I know many exquisite chemists to have consumed their own and other men's goods in search of this mystery; and to this day we see these unworthy and simple labourers cunningly deluded by a diabolical crew of gold and silver sucking-flies and leeches. But I know that many will contradict this truth; one says it is the work of the devil, and another, that the sauce is dearer than the meat."

Bergman, in summing up the evidence for and against the possibility and probability of transmutation, and founding his opinion upon the multitude of relations that have been handed down to us by different writers of apparent veracity, and one or two of which I shall presently quote, observes, that "although most of them are deceptive and many uncertain, some bear such character and testimony, that unless we reject all historical evidence we must allow them entitled to confidence." For my own part, the perusal of the histories of transmutation appears to me to furnish solid grounds for a diametrically opposite opinion. They are all of a most suspicious character; sometimes the fraud was open and intentional, seconded by juggling dexterity; at other times the performers deceived themselves; they purchased what was termed a *powder of projection* prepared by the adepts, containing a portion of gold, and when they threw it into the fire with mercury, and found that portion of gold remaining in their crucible, they had not wit enough to detect its source; but the cases which are quoted as least exceptionable are often exactly those which are really impossible: I mean, where the weight of the powder of projection, and of the lead or other

base metal taken conjointly, was exceeded by that of the gold produced. Such is HIERNES' history of PAYKUL's transmutation, who with six drachms of lead and one of powder, produced an ingot that was coined into 147 ducats; and many others. But the most celebrated history of transmutation is that given by HELVETIUS in his "Brief of the golden Calf: discovering the rarest miracle in Nature, how by the smallest portion of the Philosopher's Stone a great piece of common lead was totally transmuted into the purest transplendent gold, at the Hague in 1666:" and as it is a luminous epitome of all that has been done on this subject, I shall briefly abridge the proceedings.

"The 27th day of December 1666, in the afternoon, came a stranger to my house at the Hague, in a plebeick habit, of honest gravity and serious authority, of a mean stature and a little long face, black hair not at all curled, a beardless chin, and about 44 years (as I guess,) of age, and born in North Holland. After salutation he beseeched me with great reverence to pardon his rude accesses, for he was a lover of the Pyrotechnian art, and having read my treatise against the sympathetic powder of Sir K. Digby, and observed my doubt about the philosophic mystery, induced him to ask me if I really was a disbeliever as to the existence of an universal medicine which would cure all diseases, unless the principal parts were perished or the predestinated time of death come. I replied, I never met with an adept, or saw such a medicine, though I had fervently prayed for it. Then I said, surely you are a learned physician. No, said he, I am a brass-founder, and a lover of chymistry. He then took from his bosom-pouch a neat ivory box, and out of it three ponderous lumps of stone, each about the bigness of a walnut. I greedily saw and handled for a quarter of an hour this most noble substance, the value of which might be somewhere about twenty tons of gold, and having drawn from the owner many rare secrets of its admirable effects, I returned him this treasure of treasures with a most sorrowful mind, humbly beseeching him to bestow a fragment of it upon me in perpetual memory of him, though but the size

of a coriander seed. No, no, said he, that is not lawful: though thou wouldst give me as many golden ducats as would fill this room; for it would have particular consequences, and if fire could be burned of fire I would at this instant rather cast it all into the fiercest flames. He then asked if I had a private chamber whose prospect was from the public street; so I presently conducted him to my best furnished room backwards, which he entered," says Helvetius, (in the true spirit of Dutch cleanliness,) "without wiping his shoes, which were full of snow and dirt. I now expected he would bestow some great secret upon me, but in vain. He asked for a piece of gold, and opening his doublet showed me five pieces of that precious metal which he wore upon a green riband, and which very much excelled mine in flexibility and colour, each being the size of a small trencher. I now earnestly again craved a crumb of the stone, and at last, out of his philosophical commiseration, he gave me a morsel as large as a rape-seed; but I said, this scanty portion will scarcely transmute four grains of lead. Then, said he, deliver it me back: which I did, in hopes of a greater parcel; but he, cutting off half with his nail, said, even this is sufficient for thee. Sir, said I, with a dejected countenance, what means this? And he said, even that will transmute half an ounce of lead. So I gave him great thanks, and said I would try it, and reveal it to no one. He then took his leave, and said he would call again next morning at nine. I then confessed that while the mass of his medicine was in my hand the day before, I had secretly scraped off a bit with my nail, which I projected on lead, but it caused no transmutation, for the whole flew away in fumes. Friend, said he, thou art more dexterous in committing theft than in applying medicine; hadst thou wrapt up thy stolen prey in yellow wax, it would have penetrated and transmuted the lead into gold. I then asked if the philosophic work cost much or required long time, for philosophers say that nine or ten months are required for it. He answered, their writings are only to be understood by the adepts, without whom no student can prepare this magistery. Fling not away, therefore, thy money and goods in hunting

out this art, for thou shalt never find it. To which I replied, As thy master showed it thee, so mayest thou perchance discover something thereof to me, who know the rudiments, and therefore it may be easier to add to a foundation than begin anew. In this art, said he, it is quite otherwise; for unless thou knowest the thing from head to heel, thou canst not break open the glassy seal of Hermes.—But enough; to-morrow, at the ninth hour, I will show thee the manner of projection. But ELIAS never came again; so my wife, who was curious in the art whereof the worthy man had discoursed, teazed me to make the experiment with the little spark of bounty the artist had left me; so I melted half an ounce of lead, upon which my wife put in the said medicine; it hissed and bubbled, and in a quarter of an hour the mass of lead was transmuted into fine gold, at which we were exceedingly amazed. I took it to the goldsmith, who judged it most excellent, and willingly offered fifty florins for each ounce." Such is the celebrated history of ELIAS THE ARTIST and Dr. HELVETIUS.

SIR KENELM DIGBY, whose name is mentioned in this narrative, was a renowned dabbler in the mysterious art. Under the date of 7th November, 1651, in Evelyn's Diary, " he gave me," says Mr. Evelyn, " a certain powder with which he affirmed that he had fixed mercury before the late king. He advised me to try and digest a little better, and gave me a water which he said was only rain-water, of the autumnal equinox, exceedingly rectified and very volatile; it had a taste of strong vitriolic, and smelt like aquafortis. He intended it for a dissolvent of calx of gold; but the truth is, Sir Kenelm was an arrant mountebank."

Nearly all the alchymists attributed the power of prolonging life either to the philosopher's stone, or to certain preparations of gold, imagining possibly that the permanence of that metal might be transferred to the human system. The celebrated DESCARTES is said to have supported such opinions; he told Sir K. DIGBY that although he would not venture to promise immortality, he was certain that life might be lengthened to the period of that of the Patriarchs. His plan, however, seems to

have been the very rational one of limiting all excess of diet, and enjoining punctual and frugal meals.

The history of alchymy has been greatly enriched by the labours of the celebrated Elias Ashmole, who in 1652 published his "*Theatrum Chemicum Brittannicum*, containing severall poeticall pieces of our famous English philosophers, who have written the Hermetique Mysteries in their owne ancient Language."

The most remarkable piece in this collection is the "*Ordinall of Alchimy*, by Thomas Norton," illustrated by several comical cuts. It treats in separate chapters of the objects of the occult science; of the difficulties of attaining them; of the different methods of pursuing them; of the characters of the elements; and of the five concords, of which the first is *Patience*, the second *Assistance*, the third *Instruments*, the fourth *Situation*, and the fifth *Planetary Influence*. It is difficult to select from this production any specimen capable of conveying an idea of its merits, that can come within the limits of a quotation. Perhaps the following lines, picked out of the seventh chapter, touching "the Regiment of Fiers," may serve to convey some idea of the author's talents in the double capacity of poet and philosopher.

> "In many authors written you may see,
> *Totum consistit in ignis regimine;*
> Wherefore in all things so proceed,
> That heat work no more no less than it need;
> Wherein many of Geber's cooks
> Deceived were, though they be wise in books.
> Such heate wherewith a pig or goose is scalded
> In this arte *Decoction* it is called;
> Such heate as dryeth lawne karchiefs fair,
> In thirty operations serveth for our ayre;
> But for divisions you must use such heate,
> As cooks make when they roaste raw meate.
> *Ignis humidus* another fier alsoe
> Is, and yet seemeth *oppositum in adjecto:*
> Another fier is fier of desiccation,
> For matters which be imbibed with humectation.
> *Ignis corrodens* serveth in this arte,
> *Elementa propinqua* wisely to depart.

> By one point of excess all your work is shent,
> And one point too little is insufficient;
> Who can be sure to find its trew degree,
> *Magister magnus in igne* shall he be.
> All that hath pleasure in this booke to reade,
> Pray for my soule, and all both quick and deade.
> In this yeare of Christ 1477,
> This work was begun, honour to God in heaven."

In later times we have had two or three believers in transmutation. In the year 1782, Dr. PRICE, of Guildford, by means of a white and a red powder, professed to convert mercury into silver and gold, and is said to have convinced many disbelievers of the possibility of such change; his experiments were to have been repeated before an adequate tribunal, but he put a period to his existence by swallowing laurel-water.

Another true believer in the mysteries of art was PETER WOULFE, of whom it is to be regretted that no biographical memoir has been preserved. I have picked up a few anecdotes respecting him from two or three friends who were his acquaintance. He occupied chambers in Barnard's Inn while residing in London, and usually spent the summer in Paris. His rooms which were extensive, were so filled with furnaces and apparatus that it was difficult to reach his fire-side. Dr. Babington told me that he once put down his hat, and never could find it again, such was the confusion of boxes, packages, and parcels, that lay about the chamber. His breakfast hour was four in the morning; a few of his select friends were occasionally invited to this repast, to whom a secret signal was given by which they gained entrance, knocking a certain number of times at the inner door of his apartment. He had long vainly searched for the elixir, and attributed his repeated failures to the want of due preparation by pious and charitable acts. I understand that some of his apparatus is still extant, upon which are supplications for success, and for the welfare of the adepts. Whenever he wished to break an acquaintance, or felt himself offended, he resented the supposed injury by sending a present to the offender and never seeing him afterwards. These presents were sometimes of a curious description, and consisted usually

of some expensive chemical product or preparation. He had an heroic remedy for i lness: when he felt himself seriously indisposed, he took a place in the Edinburgh mail, and having reached that city, immediately came back in the returning coach to London. A cold taken on one of these expeditions terminated in an inflammation of the lungs, of which he died in 1805.

A few other persons of less note might be quoted as believers in transmutation, but the history of one is that of all; and, in the emphatic language of Spenser, they were doomed

> "To lose good days that might be better spent,
> To waste long nights in pensive discontent,
> To speed to-day, to be put back to-morrow,
> To feed on hope, to pine with fear and sorrow,
> To fret their souls with crosses and with cares,
> To eat their hearts through comfortless despairs:
> Unhappy wights! born to disastrous end,
> That do their lives in tedious tendance spend."

The sketch which I have given, imperfect and hasty as it has been, of the age of alchymy, will, I trust, suffice to afford a notion of the merits and eccentricities of a race of philosophists, who have certainly gained more credit and reputation than either their objects or success entitled them to. Their history is a tissue of folly, delusion, and imposture. We must, however, in forming this estimate, carefully distinguish between the persons we are now taking leave of, and those who pursued chemistry with the real view of benefitting mankind, and of elucidating attainable objects by experiments, though they pursued these ends not altogether independent of alchymical notions. Such men were Van Helmont, Basil Valentine, Beguin, Glauber, Agricola, and perhaps Paracelsus. To these experimentalists we are indebted for a rich and profitable harvest of discoveries, and with them many weighty doctrines and brilliant discoveries had their origin, which now adorn our science, and of which we daily avail ourselves, forgetful of the fountain whence they flow. But although the alchymists have given us little in the way of useful facts or applicable discoveries, their reign was fruitful in the invention of apparatus. Alembics, stills, retorts, receivers, and a variety

of whimsical and complex vessels, in glass and porcelain, are described and depicted in their works, and they not only possessed all the furnaces with which our modern laboratories are necessarily supplied, but were particularly expert in their construction, and often surprisingly happy in their application.

Art. II. *Remarks on the "Code des Médicamens ou Pharmacopée Française." By* R. Phillips, F.R.S.E., F.L.S., *&c.*

We are informed in the *Ordonnance du Roi*, prefixed to this work, that the last edition of it was published in 1748, and it is perhaps the only part of French legislation that has not been altered in the eventful period which has since occurred.

There were several reasons for supposing that the long promised Code which has now appeared would exhibit the numerous improvements so imperiously demanded by the state of science, and the nature of the Pharmacopœia of 1748, and we accordingly find that names of the highest rank in science have been mentioned to sanction the work; still I suspect that from causes which have operated in other places besides France, those who ought to have formed the Pharmacopœia have had but little share in its execution.

The remarks which I propose submitting upon this work, are not intended to be considered in the character of a regular analysis; this would be a task, for the performance of which I can scarcely imagine any sufficient inducement to exist; and it is the less necessary, because its nature is so evidently stamped upon every page, that the whole may be fairly judged of by the slightest inspection.

The avowed object in publishing the present work is one of the greatest merit; of the new dispensatory it is observed, and with great justice, "il était nécessaire de l'offrir, d'une part, chargé d'un nombre beaucoup moindre de médicamens composés, plus riche, de l'autre, en préparations simples et exécutées par des procédés décrits avec plus de correction et d'exactitude."

On opening the book at hazard among "les préparations simples," we meet with such a collection of recipes as might adorn a French cookery book, but would disgust in an English work of any description.

"*Des bouillons préparés par décoction avec des chairs d'animaux.*"

Bouillon de Vipère.

"R. Une vipère vivante, séparez en la tête et la queue, après en avoir enlevé la peau et l'avoir vidée ; conservez le sang, le cœur et le foie, qui, avec le reste, péseront environ quatre onces, ou 128.0

Coupez par morceaux ; faites cuire à vaisseaux clos, et au bain marie, pendant deux heures, dans eau commune douze onces, ou 384.0

Passez.

On prepare par le même procédé des bouillons, d'écrevisses ; de poulet ; de tortue ; de chair et de poumon ou de mou de veau ; de grenouilles ; de lézards, etc.

On ajoute à ces bouillons, suivant le besoin, diverses plantes et racines."

Having given a disgusting list of viper broth, craw-fish broth, tortoise broth, frog broth, and lizard broth, it would have been reasonable to have hoped, that the "*etc.*" would have included, without particular mention, every reptile which misery had ever used as food, or fancy for physic ; but on turning over the next page we meet with

Bouillon de Colimaçons.

R. Colimaçons de vigne séparés de leurs coquilles, No. 20, à peu près quatre onces, ou 128.0

Auxquels on ajoute, pour l'ordinaire,

deux écrevisses, équivalant environ à uneonce, ou 32.0

Eau deux livres, ou 1000.9

Lavez avec soin les colimaçons et les écrevisses ; pilez les ensemble dans un mortier de marbre avec un pilon de bois, et faites cuire à la chaleur d'un bain marie, pendant trois heures, dans une cucurbite d'étain fermée ; passez lorsque la decoction sera froide

"Si l'on veut y joindre des plantes, il faut les mêler dans la cucurbite avec les limaçons."

Whether these bouillons formed a part of the Pharmacopœia of 1748, we are not informed; if they did not, they are of course to be considered as rendering the present work "plus riche en preparations simples," and there are parts of these directions that have the strongest claim to the praise of "*exactitude*;"—the nature of the food by which the snails have been nourished, their number, weight, their being bruised on marble by wood, the use of 1,000 parts of water, and $\frac{9}{10}$ of a part more, all prove in the clearest manner, that the manufacture of this broth has received the attention of no novice in the art.

The syrups of this pharmacopœia are a numerous and nauseous assemblage; the general use of them is to render those medicines tolerable which are in themselves disagreeable; but many of the syrups in this work are not only disgusting, but must render other medicines nauseating. Sulphuret of potash, for example, forms the basis of a syrup, a compound which, in solution, is so nearly allied in flavour to putrid eggs, that syrup might be indifferently made from either; and as we have Bouillon de mou de Veau, so we have syrup of the same very eligible material. Whether the *sirop* is to sweeten the *bouillon,* or the *bouillon* to wash down the *sirop,* are questions which I have no means of deciding.

The tinctures are such as might be expected to be found associated with the syrups: take an example,—the "Teinture Aromatique composée;" it is compounded of eighteen of the most insignificant herbs, such as sage, thyme, and fennel. Surely this tincture belongs to the class of "médicamens composés" which might have been rejected.

Opium is served up in a variety of ways, no one of which appears to be good, and most of them extremely bad. The first is "Extrait d'Opium préparé au vin." In this we have merely directions for dissolving opium in wine, and evaporating the solution to the consistence of an extract. It is well known that a great portion of the more active part of opium is insoluble in water, and therefore though wine is not so good a

solvent as a stronger spirit, yet this is the least objectionable of any of the preparations of opium which the book contains. The next is " Extrait d'Opium dissous à l'eau froide suivant la méthode de Cartheuser, corrigée par Crohare." This preparation (which has a title which would be thought inconveniently long in England,) is merely a cold infusion of opium evaporated to dryness; that is to say, it is a process by which a very large quantity of opium is wasted.

The third preparation is " Extrait d'Opium preparé par la fermentation." The opium is to be boiled in water, and the solution fermented with yeast; the advantages to be derived from this operation are not easily discoverable.

The fourth preparation of opium requires no comment: It is opium purified by *six months' digestion!*

The part of the pharmacopœia which is more immediately dependant upon chemical seience, commences at p. 160, seventh section. It includes the acids: they are numerous and of course the greater number of them are useless, at least they would be so in this country. We have first " Purification de l'Acide Sulfurique;" this cannot be regarded as a useful process; it consists in re-distilling the acid, an operation which is attended with difficulty and risk, and as sulphuric acid is always diluted before it can be internally exhibited, and also before it is employed for making sulphates, every useful purification is effected by this very dilution, the sulphate of lead being precipitated.

The next preparation is " Acide Sulfureux;" if this really be used as a medicine the method probably is not bad. It consists in decomposing sulphuric acid by means of mercury, and afterwards employing the sulphate of mercury formed.

Thirdly, we have " Acide Nitrique." There are two methods of preparing nitric acid; one is that followed by manufacturers, who use one portion or atom of sulphuric acid to decompose one of nitre, or very nearly one part of acid and two of nitre; the nitric acid uncondensable by the water of the sulphuric acid, is passed through water. The other method is that directed in the London Pharmacopœia; it consists in using two

atoms, or portions of sulphuric acid, and one of nitre, or about equal weights of each. By the first process the acid is obtained with greater economy, and by the latter it is generally paler, and of more certain strength; but the framers of the French pharmacopœia, neglecting the economy of one process, and the certainty of the other, have directed 2 parts of sulphuric acid with three of nitre.

Acide Nitrique is followed by "Acide Nitreux Liquide" (is it ever solid?). The purpose for which this is prepared is to me undiscoverable. Supposing nitrites were employed in medicine, they cannot be prepared by using nitrous acid, owing to the decomposition which occurs by merely mixing the acid with a salifiant base, or with water; it cannot be externally administered as nitrous acid, even supposing such a fancy to be entertained; for, as just observed, by the action of water it is decomposed, and converted into nitric acid. It is directed to be prepared by decomposing nitric acid with copper, and passing the deutoxide of azote evolved into another portion of nitric acid: the process may answer the purpose very well, but it does not seem to be worth attaining. It is stated that the nitric acid which is to be employed, of the strength of 42°, has its specific gravity reduced to 38, by being converted to nitrous acid; there must be some error in this, for the specific gravity of the acid is considerably increased by it.

"Acide Muriatique Liquide." The directions for preparing this acid are tediously and uselessly minute. The quantity of sulphuric acid is too large; for common salt requires only $\frac{5}{6}$ of its weight of sulphuric acid to decompose it instead of an equal quantity as directed.

We have next directions for preparing chlorine under its former name of "Acide Muriatique Oxigéné liquide;" this is followed by the phosphorous and phosphoric acids, *acide acétique faible*, (distilled vinegar,) *acide acétique pure* from acetate of copper, *acide tartarique, oxalique, citrique, benzoique* by precipitation and by sublimation, acide *boracique, succinique* and *carbonique.*

The next chapter consists of the *alkalis et sous-carbonates*

alkalins. There are first, directions for preparing carbonate of potash from the ashes of wormwood, centaury, and furze; these are followed by carbonate of potash obtained by the incineration of bitartrate of potash; from the deflagration of a mixture of bitartrate of potash and nitre; and from the decomposition of bitartrate of potash by charcoal. We have thus six different preparations of carbonate of potash, or, as it is termed, "sous-carbonate de potasse." The only difference in them must of course depend upon a greater or less degree of purity, and therefore the best only ought to be retained and the others expunged. It is difficult to discover to what head of imaginary improvements the directions for preparing the carbonate of potash in six different ways belongs. These are followed by "carbonate de potasse" (bicarbonate,) prepared by passing carbonic acid into a solution of the subcarbonate.

"Sous-carbonate de Soude," prepared from barilla and "sous-carbonate d'ammoniaque," by the mutual decomposition of muriate of ammonia and carbonate of lime, follow next. The proportions directed, are 6 of the ammoniacal salt and 5 of the carbonate; this last is in too small proportion; I know both by experiment and Dr. Wollaston's scale, that at least 57 parts are required to decompose 60. In the remarks on this preparation it is stated that many are of opinion that lime is sublimed along with the carbonate of ammonia; a suspicion I never before heard of, and which is certainly groundless.

Subcarbonate of magnesia is as usual directed to be prepared from sulphate of magnesia by carbonate of potash; but forgetting the accuracy which orders 1000.9 parts of water in preparing snail broth, we are directed to take merely "quantité *suffisante*" of carbonate of potash, instead of mentioning the quantity required.

The next head is "alkalis," comprehending "potasse préparée à la chaux et fondue au feu, potasse liquide, soude caustique liquide, ammoniaque, et magnésie pure." The two first articles require no particular notice, but in preparing soude caustique liquide, that which is before called subcarbonate is here termed carbonate of soda, and as much lime is directed to be used in

preparing caustic soda as in preparing caustic potash, whereas the relative quantities required are to each other only as 1 to 2.

We proceed now to *métaux et oxides métalliques.* Of these I shall only notice the more important. It is to be observed that the metallic preparations are not arranged under one head, but are scattered about under the forms of oxides, muriates, sulphates, *&c.*, an arrangement, if arrangement it can be called, which is extremely inconvenient. The first preparation which I shall notice is the very useless and expensive one of "mercure revivifié du sulfure de mercure rouge." The object of this is of course to obtain pure mercury for other preparations; as, however, sulphuret of mercury is a preparation ordered in the pharmacopœia, and as it is of as great importance to use pure mercury in its preparation, as in most other instances, I turned to it to learn how this is managed, and the directions are to use *mercure pur.* How is this mercure pur to be obtained? this we are not informed. We are scarcely to form sulphuret from *pure* mercury, and then decompose the sulphuret, that *pure* mercury may be procured from it. Indeed on looking at the preparations of mercury, it would appear as if mercury was to be employed in different states and in different degrees of purity; thus in preparing calomel we are to use simply "mercure;" for the sulphurets of mercury, "mercure pur;" for the subsulphate, it is to be "mercure très pur;" for the nitrate "mercure pur;" and the liquid nitrate, "mercure purifié selon l'art;" protoxides of mercury, "mercure pur;" peroxide, "mercure revivifié du cinabre;" whilst another protoxide is to be prepared with "mercure purifié;" to which is added a character before unnoticed, that it is to be "liquide."

It will be understood from what I have just stated, that the preparations of mercury are numerous, and indeed much more so than they need to be. I shall notice them under one head, and not as they are placed in the pharmacopœia.

Protoxide of mercury is obtained by decomposing the crystallized nitrate by means of potash, and this is perhaps the best mode of preparing a bad medicine: the next preparation is termed "oxide noir de mercure, precipité par l'ammoniaque du

proto-nitrate de mercure." It is a very operose preparation and it can scarcely be mere protoxide of mercury, for in this instance the nitrate of mercury is not crystallized, but the solution used, without it; it must, therefore contain some pernitrate, which will of course form a triple compound with the ammonia.

The next preparations are peroxides of mercury, one by nitric acid, and the other by heating the metal in atmospheric air; these do not call for any particular observations. The preparations following these are to be found under the head of muriates, although it is well known, that according to the greater number of chemists, and especially of France, neither calomel nor corrosive sublimate contain an atom of this acid, but are chlorides. The first is calomel, called *muriate de mercure doux sublimé*: it is formed by mixing and triturating 48 parts of corrosive sublimate with 30 of mercury. Now it is stated by Mr. Brande, *Manual*, p. 299, that corrosive sublimate consists of 67 chlorine, and 190 mercury, the proportions to be inferred from Dr. Wollaston's scale are 67 chlorine, and 191.1 mercury: in order, therefore, to reduce corrosive sublimate to the state of calomel, 257 of the former must be combined with 190 of mercury, which bear to each other the proportion of 48 to 35.5 nearly; so that by directing only 30 parts of mercury, the washing to which the product is to be subjected, must dissolve nearly eight parts of corrosive sublimate, if they are not previously wasted in sublimation.

We afterwards find calomel directed to be "divisé en poudre très subtile au moyen de l'eau d'après la méthode de Josias (meaning Joseph) Jewell;" this very excellent method is properly adopted.

Calomel prepared by precipitation follows next; it is formed by dissolving mercury with the assistance of a gentle heat in nitric acid of 20° of Beaumé; that is, of about 1.163 sp. gr. It is, I believe, scarcely possible to prevent the formation of some pernitrate of mercury, and therefore some means ought to have been adopted to prevent its waste, such as adding muriate of ammonia after precipitation of the calomel to form white precipitate.

Corrosive sublimate, under the name of muriate oxigéné de

mercure, follows calomel. The directions are to mix together 48 parts of sulfate acide de mercure non lavé, with 48 of common salt, and 45 of black oxide of manganese.

These directions are extremely improper, and what purpose the oxide of manganese is to answer, it is impossible to conjecture, for the framers of the code acknowledge that the mercury is already in the state of peroxide, by the very appellation which they bestow upon the sulphate of mercury, *viz.*, sous-sulfate de mercure peroxidé. Added to this, in preparing muriatic acid, they direct equal quantities of common salt and sulphuric acid; and in this preparation they order equal weights of common salt and subsulphate of mercury; they must therefore, if they thought on the subject, either have been aware that they were ordering too much in one instance, or too little in the other, and the fact is, that they have committed both these errors; in preparing muriatic acid, the sulphuric acid is one-sixth in excess, and in preparing corrosive sublimate, it is at least, one half deficient. The remaining preparations of mercury do not require particular mention.

Antimony like mercury, is in most pharmacopœias a fruitful source of absurdity and error, and the code has not escaped the general infection.

The first preparation is " antimoine, appelé autrefois régule d'antimoine." It is obtained from the sulphuret by means of tartar and nitre; the mode is very expensive, and the product is perhaps but little purer than the metal, as it is commonly met with. Indeed the preparation of copper or iron from their ores, would appear to be quite as useful as that of antimony.

The next medicine is " oxide blanc d'antimoine préparé par l'intermède de nitre." This useless preparation, which to the credit of most pharmacopœias is rejected, is thought, and perhaps with reason, to be no disgrace to the code. Experience has long proved that peroxide of antimony is nearly inert. The next preparation is a more powerful one, it is submuriate of antimony; the process for preparing it is the simple one of decomposing the muriate by water, but the formation of the

muriate is by the old and expensive method of decomposing corrosive sublimate by means of antimony.

The antimonial basis used in making emetic tartar is the glass or sulphuretted oxide of antimony; this is not the most eligible substance to be employed, but I shall not, on the present occasion, repeat observations which I have formerly made on this subject. The proportions are 240 of tartar to 160 of the finely-powdered glass of antimony. Now as tartar actually dissolves $\frac{78}{100}$ of the glass, it is evident that of the whole 160 were soluble, that nearly 30 more would be required to saturate the tartar; and I find after repeated experiment, that there ought to be at least one-tenth more of glass used than of tartar, so that the 160 parts directed should have been 264, and in consequence of this deficiency at least half the tartar will be unconverted into tartarized antimony.

In the appendix we find "Nouvelle méthode pour préparer le tartrate de potasse et d'antimoine;" it is stated to be taken from the Edinburgh Pharmacopœia of 1813, a work which never contained it. It was probably copied from Dr. Duncan's Dispensatory, and I need merely add that the process consists in employing subsulphate of antimony, as was I believe first recommended by me in the Experimental examination of the London Pharmacopœia. The differences made in the process are two; first, the proportions of antimony and sulphuric acid are to each other as 50 to 75 instead of 1 to 2, as I advised; the smaller quantity of sulphuric acid not being sufficient to oxidize the antimony, the process is not improved. The other alteration consists in using equal weights of tartar and subsulphate of antimony, instead of 10 to 9 as I advised; this alteration is merely wasteful. There are directions also for the preparation of kermes mineral and the golden sulphur of antimony. The methods are slightly altered from those usually practised, and, as far as I can observe, without any advantage whatever.

The preparations which I shall now notice are those of iron; they are very numerous, and it may be asserted without hesitation, that many are needless even if all are good.

The first article is "oxide de fer noir préparé à l'eau." This preparation appears to be so great a favourite that two methods are given for obtaining it. In the latter of these, contained in the appendix, it is stated that iron filings moistened with water, decompose it and give out hydrogen gas, and that protoxide of iron is formed; it is moreover stated that the action is accompanied with the extrication of heat; these facts are mentioned with too much minuteness to admit of doubt as to their correctness, and yet it is generally understood that water at common temperatures is not decomposable by iron.

The next preparation is "oxide de fer noir préparé par l'acide acétique." It is formed by decomposing sulphate of iron with carbonate of soda; equal parts are directed to be employed, the precipitate obtained is to be washed, dried, and then mixed with distilled vinegar. The mixture is to be put into an earthen retort, and the fluid to be distilled in a reverberatory furnace. I am quite at a loss to conjecture the object of this employment of the vinegar; if, however, protoxide of iron be really obtained by this process, it must be by its action, for otherwise a mixture of carbonate and peroxide of iron would be formed.

After three methods of preparing protoxide of iron, we have one for forming oxide de fer brun, which is explained to be *sous-deuto-carbonate de' fer;* now the fact is, that it is a mixture of protocarbonate and peroxide of iron. It is procured by decomposing sulphate of iron with carbonate of potash, but the proportions to be employed are not given. We are afterwards informed that the same substance may be formed by exposing moistened iron filings to the air. Now the fact is, that, as already stated, the precipitate which is called merely a brown oxide, is a mixture of carbonate and peroxide; but the rust of iron obtained by moistening filings, is altogether reddish peroxide. These are followed by "oxide de fer rouge." This is prepared by decomposing sulphate of iron by heat.

Muriate of iron is to be formed by dissolving iron filings in muriatic acid, and evaporating the solution to dryness. It is by the application of heat to be converted into permuriate, for the purpose of preparing la teinture éthérée alcoolisée de

muriate de fer. Why this tincture could not be prepared by dissolving peroxide of iron in muriatic acid, which is much less troublesome, does not appear.

Muriate d'ammoniaque et de fer, is prepared by dissolving the muriates together in water, evaporating the solution to dryness, and then subliming the mass.

Tartrate de potasse, et de fer liquide, is a very imperfect preparation. Many days' digestion are required to cause tartar to act perfectly upon iron, but to obtain this solution 24 hours' digestion and two hours' boiling are judged sufficient. This preparation is followed by one which is called simply "tartrate de potasse et de fer;" it is still more imperfect than the former; the directions are to boil together to dryness 160 parts of the above described solution with 40 of tartrate of potash. The object of this preparation is not easily discoverable.

These two preparations are followed by tartrate de potasse et de fer solide; to procure this compound, tartar is to be digested for several days with half its weight of iron filings, and moistened with water and alcohol. The use of the spirit I cannot discover. The mass is to be evaporated to such an extent that it may be made into balls. Now these balls will consist of a mixture of tartrate of potash and iron, with a large quantity of iron filings totally unacted upon, for tartar dissolves scarcely more than one fourth its weight of iron filings instead of one half, as here ordered.

The last preparation of iron appears to be quite insignificant; it is malate of iron, obtained from iron filings and the juice of apples.

In concluding, it is to be observed that the arrangement of this pharmacopœia is of the most extraordinary and incomprehensible nature. Allowing for a moment that the placing the metals together is a good plan, it would be natural that they should be immediately followed by the metallic salts; but instead of this, the preparation of precipitated sulphur (by a bad method,) of phosphorus, and a chapter on æthers and alcoholized acids, follow metallic oxides; then alcaline and earthy salts, and then metallic salts; in fact, without having stated nearly

all my objections to this Code des Médicamens, I consider it as a libel upon the age and country which produced it. It is tediously minute in bad directions for bad preparations, and where minuteness would have been advantageous it is brief; and if it should escape the severe fate which it merits, the least that can be done is to dispose of it according to its directions for the syrup of sulphuret of potash, "Il faut le conserver .... couvert d'un papier noir, pour qu'il soit inaccessible à la lumière."

Art. III. *Some Observations relating to the secreting Power of Animals, in a Letter addressed to the Editor of the Journal of the Royal Institution. By* A. P. W. Philip, M.D. F.R.S.E., *&c.*

Sir, *Worcester, May* 1, 1820.

As you did me the honour to publish in the fifteenth Number of the *Quarterly Journal*, a paper relating to the agency of galvanism in the animal economy, in which I stated the reasons which seem to prove the identity of this power and the nervous influence, I trouble you with the following observations, connected with the same subject, to which I shall be much obliged to you, if they appear to deserve it, to give a place in the next number of that Journal.

Of the circumstances which tend to establish the identity of the nervous influence and galvanism, the strongest appears to be, the due performance of secretion by means of the latter, after the nervous influence is to such a degree withdrawn from secreting surfaces by dividing their nerves, that without this aid, they are no longer capable of their function. This argument of course, wholly rests on the supposition, that when we divide the nerves, we destroy the power of a secreting surface; not by any injury done to it through the medium of its wounded nerves, but by preventing the supply of something on which its secreting power depends. The consideration of this question is the object of the following paper.

It is not my intention to trouble you with any speculative opinions on this subject, but simply to inquire what inference the facts we possess relating to it warrant. Having long been engaged in the practice of medicine, and considered it as the only object of my serious studies, I have been accustomed to measure the importance of all physiological questions by the degree in which they bear on the practical part of this profession, and consequently to attach but little value to any thing, which could not be brought to the test of experiment, and admit of useful application. During some investigations which have occupied the time I could spare, from the more active duties of my profession, and writings relating to its more immediate objects, I was struck with the wonderful power of galvanism in repairing derangement of function in the animal body; and conceived, that if we could ascertain the principle on which it acts, it might be rendered an important agent in the cure of diseases. Its effects in restoring vigour to the lungs and digestive organs, under certain circumstances in the human body, of which an account is given in the *Philosophical Transactions* of 1817, and more fully in my *Inquiry into the Laws of the Vital Functions,* prove that this expectation has already been realized to such an extent, as to hold out a rational hope of further advantages, and consequently to make it worth while carefully to examine the grounds on which it is founded.

It will be necessary to premise a few observations on the relation which subsists between the nervous and muscular systems. Haller inferred from the fact, that after we have, as far as possible, deprived a muscle of nervous influence by dividing its nerves, it is still found capable of its function; that the muscular is independent of the nervous power. His opponents, however have objected to this inference, because although in his experiment, the muscle is prevented from receiving more nervous influence, it is not deprived of that already bestowed on it, either forming a necessary part of the fibre itself, or dispersed throughout its substance in nerves too small to be removed by the knife; and this objection appears to be greatly strengthened by the circumstances, that after a muscle is separated from the body,

its excitability is soon exhausted; and that those muscles, over which the will has no power, are notwithstanding supplied with nerves. It occurred to me, that this question could only be determined by some experiment, which should ascertain whether the permanence of the excitability of muscles is proportioned to the nervous influence they receive, or whether this influence tends, like other stimuli to exhaust it; for if it be proved that the permanency of the excitability is unimpaired by cutting off all fresh supply of nervous influence, and that the nervous influence exhausts this quality precisely as other stimuli do, a doubt, I conceive, cannot remain respecting its dependance on the mechanism of the muscular fibre itself. The 32d experiment related in the above Inquiry, appears to answer these questions in the affirmative, and therefore to prove the independent power of that fibre.

I am here called upon to notice an opinion on this subject, which, I believe to be altogether new, advanced by Dr. Alison in an able and ingenious paper in the last number of the *Quarterly Journal,* entitled *Observations on the Theory which ascribes Secretion to the Agency of Nerves.* While he admits the foregoing conclusion respecting the muscles of voluntary motion, he conceives, that in the muscles of involuntary motion, the nervous influence produces an " alteration in the vital power or tendency to contraction." A few observations on this, and another opinion of Dr. Alison relating to the same part of the subject, namely, that the arguments I have used against the opinion of M. le Gallois, that the power of the heart depends on the spinal marrow, are equally strong against the dependance of the secreting power on the nervous influence, will prepare us for considering the question which forms the principal subject of this paper.

Dr. Alison, I have just had occasion to observe, admits it to be proved, with respect to the muscles of voluntary motion, that stimuli applied to the brain and spinal marrow excite them merely by calling into action a power, which exists in the muscle itself; but as it is found also, that stimuli applied to the same organs produce the same effects in the muscles of involuntary motion, there is surely the strongest proof that analogy, a princi-

ple founded on the simplicity usually apparent in the works of nature, can afford, for believing the operation of the stimuli to be similar in both cases. If, however, Dr. Alison has direct evidence of his opinion, this analogy, however strong, must be disregarded. Let us inquire into the evidence he adduces.

The following paragraphs are the only passages in his paper in which he attempts to support his opinion. After some observations on the opinion of Haller, he observes, (page 108),—"The experiments of Dr. Philip have illustrated more fully than those of any other physiologist, these two different modes in which changes in the nervous system affect muscular action. The general results of his observations, and of those of Haller, Bichat, and others on this subject, may be stated to be, that the first mode of action, that is, the direct excitation of muscular fibres to contraction by impressions made on the nervous system, is confined to the voluntary muscles; and that the second mode of action, that is the alteration of the vital power or tendency to contraction of muscular fibres by impressions made on the nervous system, is chiefly exerted on the involuntary muscles."

In the foregoing observations, Dr. Alison refers to certain experiments of mine as the chief proof of his opinion. These experiments prove, that when any considerable part of the brain or spinal marrow is exposed to the action of a stimulus or sedative, the heart and blood-vessels are affected by it, in a way similar to that in which the muscles of voluntary motion are affected by the same substances applied to certain parts of the same organs. Now what relation these results have to the above opinion, I am unable to perceive. In the following paragraph indeed, Dr. Alison says, "although the term stimulus was very naturally applied by him to the substances, which quickened the action of the heart when applied to the brain or spinal marrow; yet various considerations might be stated to shew, that the effect of these substances is more correctly expressed by saying, not that they excited contractions of the muscular fibres of the heart, but that they increased the tendency of the muscular fibres of the heart to contract from the stimulus of the blood." Dr. Alison, however, does not specify, nor can I at all conjecture

what these considerations are; but he will admit that it is a consideration of weight respecting the statement he here makes, that the effect of the stimulus applied to the brain and spinal marrow on the heart, was precisely the same, whether the blood had been wholly evacuated or not. He is not himself an experimenter; and here, as in some other instances, experiences the disadvantage which often attends reasoning from the experiments of others. All the circumstances of an experiment are seldom related, the experimenter chiefly noting those which affect his own views on the subject, and thus others, who reason from them with other views, are often misled. To say that the nervous influence in one set of muscles, can increase and impair the excitability of the muscular fibre; and yet, that in another set this excitability depends wholly on the irritable nature of that fibre itself, either supposes that there are two kinds of muscular excitability, wholly differing in their nature, or implies a contradiction. The nervous influence, however independent the power of the muscular fibre, may call it into action, or it may so affect its organization as to impair its power; but how it can bestow a greater or less degree of what is derived from a different source, it would be difficult to understand, and Haller, in the passages quoted from his works by Dr. Alison, in the 108th page, has been justly regarded as forced into contradictions by the strength of his opponent's arguments, who called upon him to say, why the heart is supplied with nerves, if its excitability be wholly independent of the nervous system. Thus it appears, that Dr. Alison has not only adduced no proof of the opinion above stated, but that unless we admit of two kinds of muscular excitability, for which I believe nobody will contend, it is incompatible with opinions, the truth of which he admits.

With regard to the other opinion of Dr. Alison, relating to this part of the subject,—he observes in the 112th page, "We are not more entitled to conclude that the secretions of the stomach depend on its nerves, from finding them stopped by the division of these nerves, than Le Gallois was to conclude that the action of the heart depends on the spinal marrow, from finding it stopped in his experiments by crushing that organ." Let

us consider how far the cases are parallel. I say, that when M. Le Gallois destroyed the power of the heart, by crushing the spinal marrow, he was not at liberty to ascribe this effect to that power depending on the nervous system, because although it were independent of this system it might still be influenced through it. It was therefore necessary to observe the effects of other modes of withdrawing the nervous influence from the heart. My argument turns on the circumstance, that although the power of the heart may be destroyed by crushing the spinal marrow, it is not at all impaired by dividing the nerves which convey its in-influence. If it were equally destroyed by both, M. Le Gallois' inference I conceive, would be unavoidable. Now this is the case with the secreting power: it is equally destroyed by both; and unless Dr. Alison can point out some way of withdrawing the nervous influence from secreting surfaces without destroying their power, as has been done with respect to the heart, he cannot surely regard the two cases as at all parallel.

To the question whether the power of secretion depends on the nervous influence, we are now prepared to give, what appears to me a ready answer. The fact just stated, I conceive, affords this answer. We have no means of withdrawing the nervous influence from secreting surfaces without destroying their power. All will admit, that the only idea we attach to cause and effect is, that of two events, one of which constantly follows the other. It is therefore incumbent on those who deny that the nervous influence is essential to secretion, to shew why the usual mode of reasoning is not to be considered conclusive in this as in other cases.

But conclusive as this mode of reasoning is, it is not the only way of answering the question before us. When the nerves of a secreting surface are divided, it loses it power, either in consequence of its nervous influence being impaired, or from the immediate effects of the injury occasioned by their division. We have direct evidence against the latter opinion. If the injury, done to the nerves, were the cause of the derangement, the more the nerves are injured in the act of dividing them, the more

as happens with respect to the power of the heart, when it suffers from injury of the brain and spinal marrow, the secreting power would be deranged; but we find its derangement bearing no proportion to the injury done to the nerves, but always proportioned to the degree in which the supply of nervous influence is impaired.

Besides if the division of the nerves produces its effect by injuring the secreting organs, although the nervous influence were again restored to them, they should still be found incapable of their function. But it has been ascertained by the experiments of Dr. Haighton, related in the *Philosophical Transactions* of 1795, that, if the secreting surface is not so far deranged by the division of the nerves as to prove fatal, as soon as the parts of the nerves are sufficiently reunited, again to convey the nervous influence, the secreting power again becomes perfect. Will it be alleged, that as the division of the nerves injures the secreting organ, their re-union repairs the injury? or that by some strange coincidence the injury done to the secreting surface in such cases requires exactly the same time for its repair, which is required for the re-union of the nerve, although the two events are no ways connected?

The question before us is, when the function of a secreting surface is deranged by dividing its nerves, is this to be ascribed to its being deprived of its nervous influence, or to its being injured by the act of dividing its nerves? We know that it arises from the former, because when it is deprived of its nervous influence by any other means the effect is the same; because the effect is not at all proportioned to the degree of injury done to the nerves, but to the degree in which the nervous influence is withdrawn; and because as soon as the nervous influence is restored, it is again capable of its function.

I may here observe that in one essential respect Dr. Alison in a paper above referred to, misconceives the result of my experiments. I never found the secretions suppressed, as Dr. Alison supposes, by dividing the nerves; so far from it that it is observed in the 124th page of the second edition of the "*Inquiry*," &c.; "It deserves notice that although the eighth

pair of nerves have been divided, the food is found covered with apparently the same semifluid which we find covering the food in a healthy stomach," and it is constantly stated, that the lungs after the division of the nerves were clogged with frothy mucus. It is true that after the division of the nerves, Mr. Brodie* did not find that arsenic produced the copious secretion observed from it in the entire animal. But it is to be recollected, that he speaks of a morbid secretion produced by the irritation of the poison, and which of course would have no existence if the irritation which occasioned it were prevented, a probable means of doing which was dividing the nerves of the affected organs. It is also true that Mr. Brodie found in the newly dead animal, that, although the circulation was supported by artificial respiration, there was no secretion of urine. But this result, I believe, was by no means the consequence of the loss of nervous power, but of the diminished *vis a tergo*. From every thing I have observed of the newly dead animal, it would appear that we cannot, by artificial respiration, which cannot be made to resemble the natural function, give such vigour to the circulation, as at all approaches to that in the living animal; and the secretion of urine which takes place after death, must be inconsiderable under any circumstances. Besides the division of the spinal marrow in the upper part of the neck, in Mr. Brodie's experiment, as it did not tend to lessen the supply of nervous influence to the ganglian system, could have no effect in diminishing the little nervous influence which still continues, (as appears from the experiments in which I divided the eighth pair of nerves immediately after death,) to be sent to secreting surfaces in the newly dead animal. I can truly say, that in the living animal I never found the secreted fluids suppressed by dividing the nerves. The remaining nervous influence seemed always sufficient to occasion a separation of fluids from the blood as long as it was supplied. It is to be recollected, that neither the stomach nor lungs are wholly deprived of nervous influence by dividing the eighth pair of nerves. Such is the con-

* *Philosophical Transactions* for 1814.

nexion of the ganglian nerves, that it is impossible during life wholly to deprive any secreting organ of nervous influence. The object of my experiments was not to shew, that when a secreting surface is deprived of the whole of its nervous influence, secretion is prevented; but, that when any considerable part of it is withdrawn, the properties of the secreting fluid are so altered, that it is no longer fitted for its purposes in the animal economy.

Although I consider what is said above as decisive of the question before us, were it not for too much extending the limits of this paper, I should be happy to make a few observations on several interesting questions relating to it, on which Dr. Alison touches. On one of these as being extremely curious, I shall beg leave to detain you a few moments. In the 122d page, Dr. Alison observes, "In the child of whom we have an account by Mr. Lawrence, in his paper in the *Medico-Chirurgical Transactions*, Vol. V., page 165, there was neither brain nor cerebellum. This child lived four days, and the secretions from its stomach, bowels, and kidneys, seem to have been quite natural. Surely this is sufficient to show that the division of the eighth pair of nerves and of the spinal marrow in the neck, which stopped the secretions of gastric juice and of urine in those experiments, could not have acted by cutting off an influence essential to secretion, coming from the brain." The observation of Mr. Lawrence, that there existed over the foramen magnum "a soft tumour about equal in size to the end of the thumb," a circumstance of considerable moment in the case, is overlooked in this account. In reasoning on it, Dr. Alison forgets that if it proves any thing it proves too much. The child of course respired. To respiration the sensorial power is necessary. In the 24th volume of the *Edinburgh Review*, the reader will find the best account of well authenticated cases analogous to the case of Mr. Lawrence, perhaps any where to be met witn. In some of these not only the respiration but the more evident sensorial functions existed. In one related by Dr. Heysham of Carlisle, there was nothing in place of brain but a brown vascular mass. "There was not the least appearance of a cerebrum, cerebellum, or any medullary substance whatever; yet this child was full grown,

well-proportioned, and seemed in perfect health. It moved its limbs with agility, swallowed well, and took a sufficient quantity of nourishment. All the external organs of sense were perfect. The eyes were as full and lively as in any other child of the same age. The iris evidently contracted on the application of light, and from some other observations which Dr. Heysham then made, he had no doubt that vision was perfect." (Page 447.) A similar case is given on the authority of Sir Everard Home, where the only appearance of brain was a little medullary pulp behind the orbits. Are we to conclude from such cases, that the sensorial power has no dependance on the brain?

The following are the only facts with which I am acquainted, that tend to throw light on this very obscure subject. In other instances we see the functions of vital organs going on, when, as far as we can judge by inspecting the organs, the structure on which these functions depend is wholly lost. Those who are in the habit of seeing the dissection of phthisical subjects, know how strikingly this observation is sometimes illustrated by the state of the lungs. The brain, it appears from many observations, admits under certain circumstances of a great degree of distension and compression, without its functions being materially deranged. If we suppose that it possesses these properties to such a degree as occasionally to admit of being thinned to a membrane, or contracted to a small nob, without its functions being deranged, the above cases may be explained. It also deserves particular attention in considering such cases, that it appears from the experiments of M. Le Gallois, in which, beginning from the upper part, he gradually sliced off the brain and cerebellum, that the functions of the eighth pair of nerves, on which both the sensorial power employed in respiration, and the power of secretion in the viscera, as far as the brain is concerned, chiefly depend, continued after the whole of both organs had been removed, except the parts in the immediate neighbourhood of the origin of these nerves, parts hardly admitted to belong to the brain. But in the present state of our knowledge, it would be profitless to pursue this subject farther. It is enough to remind the reader that Dr.

Alison's mode of reasoning from it is inadmissible. With respect to the fact that considerable parts of the brain have been suddenly lost without materially affecting secretion, the same answer applies, neither do such losses of brain in general materially affect the sensorial power. Were we to attempt to explain this, we might say, in conformity with the opinion of some writers, that it arises from the same cause that the loss of an eye or ear does not materially affect the sight or hearing, nor the loss of a kidney the secretion of urine.

Much as Dr. Alison and I differ in many respects, I cannot conclude without calling your attention to what appears to me, the very correct view taken by him of the question respecting the identity of the nervous influence and galvanism. Those who have hitherto objected to my conclusion from the experiments in question*, either maintain, that we must rather suppose

---

* I have much pleasure in referring to a paper in the last number of the *London Medical and Physical Journal*, by Clarke Abel, M.D. F.R.S., Physician at Brighton, in which he gives an account of very careful and well conducted repetitions of my galvanic experiments on the lungs and stomach, made in the presence of several medical gentlemen. In one of these repetitions he employed a comparatively weak, and in the other a considerable power, of galvanism. In the former, although the galvanism was not of sufficient power to occasion evident digestion of the food, the constant effects of dividing the eighth pair of nerves, the efforts to vomit, and the difficulty of breathing, were prevented by it. These symptoms occurring when it was discontinued, and disappearing on its re-application. "The respiration of the animal," he observes, "continued quite free during the experiment, except when the disengagement of the nerves from the tin foil rendered a short suspension of the galvanism necessary during their re-adjustment." "The non-galvanized rabbit breathed with difficulty, wheezed audibly, and made frequent attempts to vomit." In the latter experiment in which the greater power of galvanism was employed, digestion went on as in my experiments. The galvanism proved fatal in nine hours. He remarks the greater moisture of the cardiac portion of the food, which is peculiarly characteristic of the healthy state of the stomach in the rabbit.—See the first section of Chapter seven, part second, of my *Inquiry*. "The pyloric part of the mass," he observes, "was of a brownish colour and resembled the contents of a healthy rabbit's stomach, except towards the centre, where it had a greenish maculated appearance, seemingly from the mixture of parsley in different states of digestion, while the stomach

the existence of a power capable of the most complicated functions of the nervous influence, yet distinct from it, than admit the identity of these powers; and that, without attempting to shew that in any of their properties they are incompatible with each other; an instance of more erroneous reasoning than which it would, as far as I am capable of judging, be impossible to adduce; or that galvanism excites the nerves of the part to prepare nervous influence, and thus perform the office of the brain or spinal marrow, of which every fact relating to their functions proves them incapable. We might as well, I conceive, suppose a bone, as a nerve capable of preparing this influence. They are mere channels through which it passes, and when the little they retain after their separation from the brain and spinal marrow is exhausted, they have no capability of forming more. Dr. Alison, far from adopting either of these opinions, declares without hesitation, that the only way of refuting my inference is to prove that the nervous influence is not essential to secretion. "Here we have," he observes, "the nervous influence cut off, and yet secretion going on. On the supposition that the nervous influence is really essential to secretion, this can only be explained by supposing the galvanic influence which is substituted for it to be really the same thing. If, therefore, we can make it probable that the changes which occur in the nervous system are not galvanic actions, we need go no farther after these experiments in order to shew that the nervous system is not necessary to secretion:" and in page 119, "if they," that is the changes in the nervous system, "be not galvanic, Dr. Wilson Philip's experiment, above referred to, becomes an *experimentum crucis* against their being essential to secretion."

---

of the non-galvanized rabbit contained only a continuous mass of masticated parsley." He closes his account of this experiment with the following observations: "From this experiment it seems legitimate to infer, that galvanism of a certain power passed in a continued stream through the thoracic and gastric portions of the eighth pair of nerves, after their division, will produce the phenomena of digestion. It entirely corresponds, both in its details and results, with the experiments of Dr. Wilson Philip."

According to this view of the subject, which has always appeared to me the only correct one, when we prove that after deranging the functions of a secreting surface by dividing its nerves, we can restore its healthy state by galvanism, we prove the identity of this power with that on which secretion depends; and that secretion depends on the nervous power, the facts just laid before the reader, as far as I am able to judge, appear sufficiently to evince.

The experiment alluded to in the above passages quoted from Dr. Alison's paper, even by his admission, being an *experimentum crucis* of the identity of galvanism and the secreting power, must, except on the supposition that secretion does not depend on the nervous influence, do away all that he says repecting our not being able to point out how galvanism is excited, or how it effects so great a variety of changes in the animal body. We must of course admit that our knowledge of this principle is very limited*; but we see nothing in the phenomena of the nervous influence, on the supposition that it is galvanism, more extraordinary than many analogous facts. How is electricity collected and subjected to the will of electric animals, so that they cannot only evolve it at pleasure, but according to M. Humboldt's experiments, direct it to any particular part of the body. How does it happen, that the electricity of the gymnotus, which is strong enough to deprive a horse of power, cannot affect the nicest electrometer? Can any one who has read the experiments of Sir James Hall on the various results obtained under different circumstances by the agency of caloric, even on the same substances, and those few in number,

* When Dr. Alison, towards the end of his paper, accuses me of supporting one hypothesis by another, he forgets that what I say on the subject under discussion is thrown out as a mere suggestion, namely, that on the supposition of the nervous influence being galvanism the difficulties stated are explicable: on the supposition of its being something no-where existing, but when formed by the brain and spinal marrow, they are wholly inexplicable; referring, however, to future investigations for any knowledge that may be acquired on the subject. I allude chiefly to the phenomena of the fœtus previous to the formation of any part of the brain and spinal marrow.

be surprised, that a variety of products should be the results of the agency of galvanism, in the animal body, of which the component parts are so numerous and so differently circumstanced?

Art. IV. *Description of a New Apparatus for the Combustion of the Diamond.*

In the course of the experiments which Sir Humphry Davy made at Florence on the combustion of the diamond, he discovered that when the gem began to burn in an atmosphere of pure oxygen, having free access to it on all sides, it would continue burning, though the original source of heat were removed, until the particles were rendered so small as to be too readily cooled by the little platinum tray which supported them. (*Philosophical Transactions*, 1814, p. 557.) In consequence of this observation, an idea arose, that if the diamond were well heated, and then introduced into oxygen, it would go on burning, and afford an easy method of exhibiting its combustibility. Upon trial this was found to be the case, and a notice to that effect put in this Journal. (Vol. iv. p. 155). Since then, an apparatus of this kind has been perfected, and is now represented in *Plate* 3, *Fig*. 1.

It consists of a glass globe, of the capacity of about 140 cubical inches, furnished with a cap, having a large aperture; the stop-cock, which screws into this cap, has a jet, A, rising from it, nearly into the centre of the globe, this is destined to convey a small stream of hydrogen, or other inflammable gas. Two wires, *c. c.*, terminate at a very little distance from each other, just above this jet, and are intended to light the stream of hydrogen by electrical sparks; one of them commences from the side of the jet, the other is inclosed and insulated nearly in its whole length in a glass tube: the tube and wire pass through the upper part of the stop-cock, and the wire terminates on the outside in a ball or ring, D, at which sparks are to be taken from the machine, either directly or by a chain. On the end of the jet is fixed, by a little socket, a small

capsule, B, made of platinum foil. This capsule is pierced full of small holes, and serves as a grate to hold the diamonds. Its distance is about three quarters of an inch from the end of the jet; and the arm, by which it is supported, is bent round, so that the stream of hydrogen shall not play against it. The stop-cock screws, by its lower termination, on to a small pillar fixed on a stand, and at the side of this pillar is an aperture by which a bladder filled with gas may be connected with the apparatus.

On using the apparatus, the diamond is to be placed in the capsule, and then the globe being screwed on to the stop-cock, the latter is to be removed from the pillar and placed on the air-pump; the globe is then to be exhausted and afterwards filled with pure oxygen: or, least the stream of oxygen in entering should blow away the diamond, the globe may be filled with the gas first, and then, dexterously taking out the stop-cock for a short time, the diamonds may be introduced and the stop-cock replaced. The apparatus is then to be fixed on the pillar, and a bladder of hydrogen gas attached to the aperture. Now, passing a current of sparks between the wires, a small stream of hydrogen is to be thrown in, which inflaming, immediately heats the capsule and diamonds white hot; the diamonds will then enter into combustion, and the hydrogen may be immediately turned off and the bladder detached. The diamonds will continue to burn, producing a strong white heat, until so far reduced in size as to be cooled too low by the platinum with which they lie in contact.

When the flame of hydrogen is used to heat the diamonds, it is evident a little water will be found in the globe, but this is of no consequence except in attempts to detect hydrogen in the diamond, the inconvenience may be obviated, if required, by using the flame of carbonic oxide. As however no hydrogen has at any time been detected in the diamond, it is better to use that gas as the heating agent; for then the carbonic acid, produced by the combustion, is unmixed with that from any other source, and may be collected, and its quantity ascertained.

M. F.

ART V. *A Description of two new Birds of the Genus Pteroglossus, of Illiger. By* William Swainson, Esq., F.L.S., M.W.S.

THE Genus Pteroglossus has, with great propriety, been instituted by the celebrated Illiger, who, in his Prodromus, first defined its characters: they consist of that division of the Linnæan Toucans, called by the French *Aracare*; and, although one of their first ornithologists has done much to elucidate these singular birds, no writer has yet clearly defined the species; indeed, M. Vieillol has, in his generic work, again united them to the toucans, although he adopts Illiger's name for quite a different family! I shall, for the present, confine myself to the description of two new species, both of which are now in the possession of Lord Stanley, who most politely favoured me with them for examination.

PTEROGLOSSUS *torquatus.*
Collared Aracari.

P. nigro virescens, capite nigro, collo uropigio et fascia lata pectorali rubris, torque et ventre flavis, mandibule superiore flavo, inferiore albo, subfine cæruleo.

Blackish green Aracari with black head; red neck, rump, and pectoral bar; yellow gorge and belly; upper mandible yellow, lower one white, the end blue; size rather less than the green Aracari. Total length thirteen inches and a half; bill two inches eight lines, from the gape to the tip; upper mandible convex above the margin, moderately toothed, the colour pale but clear yellow, with a narrow whitish line at the margin towards the base and parallel with the teeth, between each of which is a short black line; the under mandible is white at the base, the other half blue, and both mandibles have a tumid marginal orange line at their base, inside which in the under mandible only, is a line of black; orbits chesnut. Upper part of the head as far as the nape black, which changes to crimson

on the upper neck, and its sides blending into the dark sea green of the back, wings, tail, and its terminal covers; the wings when closed measure four inches eight lines in extreme length and are rounded, the quills blackish-brown externally margined with olive green; rump and upper tail covers crimson; tail five inches long, colour of the quills and much cuneated, the outermost feather on each side being only one inch and three quarters long. Sides of the head, ear-feathers, and fore-part of the neck dark chesnut, divided from the red band which reaches to the middle of the body by a narrow crescent-shaped band of yellow on the upper margin of which the feathers are tipt with black, lower half of the body, vent, and under tail covers yellow, the points of some of these last feathers tinged with red. Flank and thighs olivaceous green, legs dark green, claws brownish black.

This bird was sold at the lamentable dispersion of the noble museum of Mr. Bullock. It is evidently not quite arrived at its full brilliancy of plumage, but sufficiently so to enable its being described with perfect safety; it was stated to come from the French colonies in South America, and is the only specimen I have yet seen; the colours of the bill had preserved tolerably well; I have little doubt of its being the female bird, for in many of the Aracaris, the only difference that exists between the sexes is in the colour of the throat, which in the male is black, in the female chestnut, whereas, in the genuine toucans, the size (not the colour) of the bill I have always found to be a constant discrimination.

PTEROGLOSSUS *sulcatus.*
Grooved-bill Aracari.

P. viridis subtus pallidior, jugulo albescente, circa oculos cæruleus, rostrum duabus sulcis longitudinalibus incisum.

Green Aracari, beneath paler, throat whitish, round the orbits blue, bill with two lateral longitudinal indented grooves.

Total length twelve inches, bill in extreme length three inches much curved, and shaped different from most of the

Aracaris, being very deep at the base, from which it gradually narrows to a sharp point at its tip, the upper part is convex and somewhat tumid, the sides are compressed, and the upper mandible has two broad slightly-indented grooves on each side, the base of this mandible has a few transverse wrinkles, and the serratures deep and unequal. The lower mandible is only half the depth of the upper, the sides concave, and the serratures less, the colour in the dead bird was black, the base of the lower and the upper half of the superior mandible being rufous with a whitish marginal transverse line on each side; the nostrils are more lateral than any of the species I have yet seen, being placed in a line with the eye, the orbits naked and reddish brown, the feathers encircling which, particularly beneath the eye, are vivid cerulean blue. The whole upper plumage of the bird is parrot-green, paler beneath, whereas on the cheeks there is a strong tinge of golden yellow, the throat dusky white, wings short rounded five inches long, inner shafts of the quills black, margined with yellowish white, tail cuneated four inches and a half long and green, the four middle feathers of equal length, legs dusky black.

This rare and extraordinary bird has a peculiarity of habit, rather dissimilar from any of the Aracari, yet it most clearly belongs to the genus. I first saw it in a small case of birds brought from New Spain, in the possession of my friend E. Falkner, Esq., of Fairfield, who kindly lent it me for inspection. Another existed in Mr. Bullock's Museum, which came from Peru, and which is now in the collection of Lord Stanley. The generic name was suggested to me by Professor Lamminck, while showing him my ornithological drawings, and to whom it was also unknown.

Art. VI. *Meteorological Journal, shewing the Quantity and Pressure of the Aqueous Atmosphere*, &c., *three times in the Day*. *By*. J. F. Daniell, Esq., F.R.S., M.R.I.

METEOROLOGICAL JOURNAL—*continued from page 137.*

Date. 1820.	Hour.	Moon's Age.	Pressure. Of the whole Atmosphere.	Pressure. Continuous rise and fall of Barometer.	Pressure. Of the Vapour.	Temperature. Of the Air.	Temperature. Of the Vapour.	Temperature. Difference.	Weight in grs. of Vapour in the space of a cubic foot. As expanded by the existing temperature.	Weight in grs. of Vapour in the space of a cubic foot. Maximum at the temperature of the Vapour.	Weight in grs. of Vapour in the space of a cubic foot. Maximum at the temperature of the Air.	Temperature. Highest.	Temperature. Lowest.	Temperature. Of a good radiator on the ground.	Quantity of rain.	De Luc's Hygrometer. Dry.	De Luc's Hygrometer. Moist.	Force of evaporation in grs. from a surface 6 ins. diameter.	WIND. Direction.	WIND. Force.	PREVAILING CLOUDS.	OBSERVATIONS.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	17	18	19	20	21	22
Jan. 12	10		29.94	....	0.116	25	17	8	1.389	1.411	1.831	..	..	....	....	..	12	0.24	E	high	scud and stratus	Clearing.
	4		30.03	....	0.120	25	18	7	1.407	1.428	1.831	25	..	....	....	..	..	0.16	....	brisk	ditto ditto	Light snow showers.
	11		30.10	+0.43	0.116	20	17	3	1.402	1.411	1.529	..	11	5	....	..	11	0.06	....	little	overcast	Stars dull.
13	10		30.05	....	0.116	21	17	4	1.400	1.411	1.586	..	..	....	....	..	10	0.08	NE	ditto	cirri and cirro-cumuli	Very fine and sharp—stelliform snow.
	3		30.05	—0.05	0.168	28	27	1	1.955	1.959	2.030	28	..	....	....	..	..	0.04	....	brisk	stratus and mist	Foggy—light snow showers.
	11		30.10	....	0.116	22	17	5	1.397	1.411	1.642	..	22	16	....	..	12	0.10	....	ditto	overcast	Fine till nine, then overcast.
14	10		30.12	+0.07	0.116	25	17	8	1.389	1.411	1.831	..	..	....	....	..	11	0.18	E	ditto	stratus and scud	Light snow showers.
	3		30.09	....	0.116	26	17	9	1.385	1.411	1.897	26	..	....	....	..	..	0.21	....	ditto	ditto ditto	Dull day with a few flakes of snow.
	11		30.01	....	0.090	21	10	11	1.065	1.089	1.586	..	19	14	....	..	10	0.32	....	ditto	none	Stars bright and clear.
15	10		29.79	....	0.090	12	10	2	1.085	1.089	1.156	..	..	....	....	.	9	0.04	NW	little	scud and fog	Foggy but fine.
	3	●	29.71	....	0.112	21	16	5	1.322	1.337	1.586	..	..	....	....	..	..	0.10	....	ditto	mist	Fine, but misty.
	11		29.66	....	0.162	28	26	2	1.890	1.897	2.030	28	19	13	....	..	14	0.05	....	ditto	overcast	Very dark.
16	10		29.65	....	0.139	22	22	..	1.642	....	....	..	.	....	....	..	16	....	....	ditto	thick mist	Fine—great deposition of hoar frost.
	4		29.68	....	0.156	25	25	..	1.831	....	....	26	..	....	....	..	..	....	....	ditto	mist	Cloudless, but misty.
	11		29.68	....	0.156	26	25	1	1.828	1.831	1.897	..	22	12	....	..	15	0.03	....	ditto	overcast	Dull—stars dim.
17	10		29.60	....	0.200	32	32	..	2.317	....	....	..	..	....	....	..	18	....	W	ditto	fog and scud	Hoar-frost thaw.
	4		29.57	....	0.200	32	32	..	2.317	....	....	33	..	....	....	..	..	....	....	ditto	ditto ditto	Dull day.
	11		29.51	....	0.162	32	26	6	1.876	1.897	2.317	..	27	25	....	..	16	0.15	....	ditto	overcast	Much snow.
18	10		29.39	....	0.180	29	29	..	2.096	....	....	..	..	....	....	..	17	....	NE	brisk	stratus	Snow.
	4		29.32	....	0.200	32	32	..	2.317	....	....	..	..	....	....	..	..	....	SE	high	ditto	Rain froze on the ground.
	11		29.02	....	0.221	35	35	..	2.545	....	....	35	32	30	....	..	27	....	S	stormy	overcast	Hard steady rain.
19	10		28.89	—0.79	0.294	45	43	2	3.313	3.326	3.570	..	..	....	...	..	32	0.14	SW	high	stratus and scud	Mild and damp.
	4		28.94	....	0.273	43	41	2	3.095	3.106	3.326	45	..	....	....	..	..	0.11	W	brisk	ditto ditto	Dull day—few drops of rain.
	11		28.98	....	0.207	33	33	..	2.393	....	....	..	27	21	....	..	24	....	....	ditto	overcast	Very dull.
20	10		29.50	+0.61	0.152	30	26	4	1.883	1.897	2.162	..	..	....	....	..	17	0.09	N	little	cirri and haze	Very fine.
	4		29.45	....	0.150	32	24	8	1.737	1.763	2.317	32	..	....	....	..	..	0.26	ES	brisk	stratus	Day fine—afternoon dull.
	11		29.13	....	0.200	32	32	..	2.317	....	....	..	32	31	....	..	18	....	SE	stormy	overcast	Deep fall of snow.
21	10		29.12	—0.38	0.214	35	34	1	2.433	2.438	2.545	..	..	....	....	..	17	0.03	SW	brisk	stratus	A little sleet.
	4		29.26	....	0.207	33	33	..	2.393	....	....	35	..	....	....	..	..	....	NW	high	ditto	Light showers—dull.
	11		29.63	....	0.156	28	25	3	1.821	1.831	2.030	..	22	14	..	..	16	0.11	N	brisk	none	Fine—moon and stars bright.
22	10	☽	29.96	....	0.139	25	22	3	1.631	1.642	1.831	..	..	....	....	..	15	0.06	NE	little	haze	Very fine.
	3		30.01	....	0.162	28	26	2	1.890	1.897	2.030	28	..	....	....	..	..	0.05	....	ditto	ditto	Perfectly fine.
	11		30.07	+0.95	0.139	22	22	..	1.642	....	....	..	19	13	....	..	12	....	....	ditto	fog	Foggy and cold—moon red.
23	10		30.02	....	0.207	33	33	..	2.393	....	....	..	..	....	....	..	14	....	SW	ditto	stratus and fog	Fine but misty.
	4		29.98	....	0.207	36	36	..	2.393	....	....	..	..	....	....	..	..	....	....	brisk	ditto ditto	Ditto ditto.
	11		29.90	....	0.229	36	36	..	2.629	....	....	36	33	29	....	..	16	....	S	high	overcast	Warm and damp.
24	10		29.79	....	0.214	39	34	5	2.414	2.438	2.900	..	..	....	....	..	17	0.16	SW	brisk	thin stratus	Fine—sun misty.
	4		29.71	—0.36	0.273	41	41	..	3.106	....	....	..	..	....	....	..	..	....	....	high	stratus and scud	Light showers—damp.

METEOROLOGICAL JOURNAL—*continued.*

Date. 1820.	Hour.	Moon's Age.	Pressure. Of the whole Atmosphere.	Pressure. Continuous rise and fall of Barometer.	Pressure. Of the Vapour.	Temperature. Of the Air.	Temperature. Of the Vapour.	Temperature. Difference.	Weight in grs. of Vapour in the space of a cubic foot. As expanded by the existing temperature.	Weight in grs. of Vapour. Maximum at the temperature of the Vapour.	Weight in grs. of Vapour. Maximum at the temperature of the Air.	Temperature. Highest.	Temperature. Lowest.	Temperature. Of a good radiator on the ground.	Quantity of rain.	De Luc's Hygrometer. Dry.	De Luc's Hygrometer. Moist.	Force of evaporation in grs., from a surface 6 ins. diameter.	Wind. Direction.	Wind. Force.	Prevailing Clouds.	Observations.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		18	19	20	21	22
Jan. 24	10		29.77	....	0.294	43	43	..	3.326	....	....	43	39	36	....	..	24	....	....	brisk	stratus and scud	Close and damp—rain.
25	10		29.79	+ 0.08	0.283	42	42	..	3.214	....	....	..	..	....	....	..	26	....	S	ditto	stratus and mist............	Damp—showers.
	4		29.63	....	0.283	42	42	..	3.214	....	....	43	..	....	....	..	..	....	....	ditto	ditto ditto...............	Steady rain.
	11		29.44	— 0.35	0.283	42	42	..	3.214	....	....	..	39	35	....	..	23	....	....	high	overcast	Oppressive—much rain.
26	10		29.47	....	0.305	41	41	..	3.452	....	....	..	..	....	....	..	26	....	W	brisk	stratus, scud, and mist......	Rain—clouds breaking.
	4		29.59	....	0.328	47	46	1	3.662	3.699	3.815	48	..	....	....	..	..	0.07	....	ditto	cirri and stratus	Light showers—fine.
	11		29.59	+ 0.15	0.328	46	46	..	3.699	....	....	..	41	42	....	..	25	....	....	ditto	overcast	Damp—hot—hard showers.
27	10		29.56	....	0.316	47	45	2	3.557	3.570	3.815	..	..	....	....	..	23	0.13	SW	ditto	haze	Very fine.
	3		29.50	....	0.328	49	46	3	3.675	3.699	4.068	50	..	....	....	..	..	0.18	....	ditto	cumulo-stratus	Beautiful day—light showers.
	11		29.34	— 0.25	0.328	46	46	..	3.699	....	....	..	41	40	....	..	22	....	....	ditto	ditto ditto.........	Fine—moon watery—rain.
28	10		29.56	....	0.283	43	42	1	3.208	3.214	3.326	..	..	....	....	..	20	0.06	NE	ditto	ditto ditto...............	Dull morning.
	3		29.73	....	0.237	43	37	6	2.687	2.717	3.326	44	..	....	....	..	..	0.36	N	high	ditto ditto.........	Fine—light showers.
	11		29.94	....	0.263	41	40	1	2.991	2.999	3.106	..	37	33	....	..	17	0.05	....	brisk	overcast	Dull—showers.
29	10		30.09	+ 0.75	0.229	40	36	4	2.609	2.629	2.999	..	..	....	....	..	15	0.13	NE	little	cumulo-strati	Morning fine, but grey.
	3		30.06	....	0.229	42	36	6	2.600	2.629	3.214	43	..	....	....	..	..	0.21	NW	ditto	ditto and scud............	Ditto ditto—sun shone at intervals.
	11	○	30.05	....	0.237	40	37	3	2.702	2.717	2.999	..	38	37	....	..	13	0.10	....	ditto	ditto........................	Night fine.
30	10		29.99	....	0.283	42	42	..	3.214	....	....	..	..	....	....	..	15	....	W	ditto	stratus and mist	Rain in the morning—dull.
	4		29.99	....	0.316	45	45	..	3.570	....	....	45	..	....	....	..	..	....	....	ditto	ditto ditto...............	Rain—damp.
	11		29.96	....	0.305	44	44	..	3.452	....	....	..	39	31	....	..	17	....	....	ditto	overcast	Small rain—very damp.
31	10		29.92	....	0.283	42	42	..	3.214	....	....	..	..	....	....	..	17	....	SW	ditto	cirri and haze	Very fine.
	3		29.91	— 0.18	0.294	46	43	3	3.307	3.326	3.699	45	..	....	....	..	..	0.13	....	ditto	ditto cumulo-stratus	Beautiful day.
	11		29.97	....	0.294	43	43	..	3.326	....	....	..	34	28	....	..	15	....	....	ditto	overcast	Moon very watery.
Feb. 1	10		29.89	....	0.237	37	37	..	2.717	....	....	..	..	....	....	..	13	....	SW	little	cirri-scud and haze..........	Great deposition of moisture—fine.
	3		29.81	....	0.214	40	34	6	2.408	2.438	2.999	41	..	....	....	..	..	0.19	S	ditto	thin scud	Sun shone all day.
	11		29.77	....	0.214	34	34	..	2.438	....	....	..	27	23	....	..	12	....	....	ditto	none.........................	Beautiful night—great deposition.
2	10		29.74	+ 0.21	0.200	32	32	..	2.317	....	....	..	..	....	....	..	11	....	ES	ditto	stratus and fog..............	Dull—hoar frost.
	4		29.77	....	0.200	35	32	3	2.304	2.317	2.545	35	..	....	....	..	..	0.10	....	ditto	ditto ditto and cumulo-strati	Dull—cold and damp.
	11		29.81	....	0.214	34	34	..	2.438	....	....	..	32	30	....	..	13	....	....	ditto	overcast	Very dull.
3	10		29.87	....	0.193	33	31	2	2.231	2.210	2.393	..	..	....	....	..	13	0.06	NE	ditto	stratus and cumulo-strati ..	Dull, but clear.
	4		29.90	....	0.186	34	30	4	2.146	2.162	2.438	37	..	....	....	..	..	0.12	N	ditto	ditto ditto................	Dull and cold.
	11		29.94	....	0.193	33	31	2	2.231	2.210	2.393	..	32	30	....	..	11	0.06	....	ditto	overcast	Ditto ditto.
4	10		29.95	....	0.193	34	31	3	2.226	2.210	2.138	..	..	....	....	..	11	0.09	SW	ditto	stratus and mist	Ditto ditto.
	3		29.95	....	0.186	37	30	7	2.132	2.162	2.717	37	..	....	....	..	..	0.21	....	ditto	ditto........................	Ditto ditto.
	11		29.96	+ 0.22	0.207	33	33	..	2.393	....	....	..	32	32	....	..	13	....	....	ditto	haze	Moon and stars dim.
5	10		29.89	....	0.254	40	39	1	2.701	2.900	2.999	..	..	....	....	..	14	0.03	S	ditto	stratus and haze	Overcast.
	4		29.85	....	0.283	42	42	..	3.214	....	....	43	..	....	0.02	..	..	....	SW	brisk	ditto and scud............	Dull—small rain.
	11		29.84	....	0.273	41	41	..	3.106	....	....	..	34	34	....	..	17	....	....	little	overcast	Dull and warm.
6	10		29.77	— 0.19	0.305	44	44	..	3.452	....	....	..	..	....	0.04	..	20	....	W	ditto	stratus and mist	Copious small rain.

	4		29.90		0.283	47	42	5	3.184	3.214	3.815	47						0.30	NW	brisk	cumulo-stratus and scud	Clouds higher.
	11		29.99		0.316	45	45		3.570				40	37			24			little	overcast	Close and very damp.
7	10	☾	30.06		0.339	47	47		3.815								23		SW	ditto	stratus and mist	Dull and damp.
	4		30.06		0.363	49	49		4.068			49								ditto	ditto ditto	Ditto ditto—oppressive.
	11		30.06		0.328	46	46		3.699				41	41			20			ditto	overcast	Ditto ditto ditto.
8	10		30.06	+ 0.29	0.316	45	45		3.570								19			ditto	stratus and mist	Ditto ditto ditto.
	4		30.04	— 0.02	0.316	46	45	1	3.563	3.570	3.699	46						0.05		brisk	ditto ditto	Ditto ditto ditto.
	11		30.06	+ 0.02	0.316	45	45		3.570				38	31			20			little	overcast	Ditto ditto ditto.
9	10		29.95		0.283	43	42	1	3.268	3.214	3.326						19	0.05		ditto	cirro-cumuli and scud	Fine—great deposition.
	4		29.85		0.305	46	44	2	3.439	3.452	3.699	46						0.09		ditto	cirri and scud	Nearly cloudless—clear and warm.
	12		29.79	— 0.27	0.273	41	41		3.106				40	35			17		SWS	ditto	overcast	Stars dim—rain.
10	10		29.80		0.328	46	46		3.699						3.03		15		WN	ditto	stratus-cumulo-stratus&mist	Damp—oppressive—rain.
	4		29.90		0.254	47	39	8	2.857	2.900	3.815	47						0.41	N	brisk	cumuli and cumulo-stratus	Very fine.
	11		29.90		0.229	36	36		2.629				32	26			10			little	none	Beautiful star-light.
11	10		30.02	+ 0.23	0.245	40	38	2	2.793	2.803	2.999						13	0.17	W	ditto	mist	Very fine—great deposition.
	4		29.94		0.305	45	44	1	3.440	3.452	3.570	45						0.04		ditto	stratus and scud	Fine—misty—dull.
	11		29.80		0.294	43	43		3.326				39	36			17			brisk	overcast	Very dull.
12	10		29.80	— 0.22	0.283	42	42		3.214			42					16		S	little	stratus and cumulo-stratus	Rain—misty.
	4		29.88		0.273	41	41		3.106						0.46				SE	brisk	ditto ditto and scud	Rain all day.
	11		29.95		0.263	40	40		2.999				38	36			16			ditto	overcast	Dull and damp.
13	10		29.95	+ 0.15	0.229	42	36	6	2.600	2.629	3.214						13	0.21	SW	little	stratus and cumulo-stratus	Grey and clear.
	4		29.92	— 0.03	0.214	42	34	8	2.400	2.438	3.214	42						0.31		ditto	ditto ditto	Fine—sun shone from twelve to one.
	11		29.99		0.229	36	36		2.629				32	29			15			ditto	overcast	Dull—foggy smell.
14	10	●	30.12		0.214	38	34	4	2.417	2.438	2.803						16	0.12		ditto	cumulo-stratus	Grey and clear,
	3		30.13		0.193	42	31	11	2.192	2.240	3.214	42						0.46	W	brisk	ditto	Fine.
	11		30.16		0.221	36	35	1	2.538	2.545	2.629		31	29			13	0.02		little	overcast	Dull.
15	10		30.20		0.200	32	32		2.317								12		NE	brisk	stratus	Dull and bleak.
	3		30.20		0.200	36	32	4	2.298	2.317	2.629	36						0.15		ditto	cirri	Fine and fresh.
	11		30.20	+ 0.28	0.180	29	29		2.096				26	23			12			ditto	none	Stars bright—great deposition of hoar-frost.
16	10		30.16		0.168	28	27	1	1.955	1.959	2.030						11	0.03	E	little	haze	Hoar-frost—very fine.
	4		30.10		0.193	32	31	1	2.235	2.240	2.317	32						0.03		brisk	cumulo-stratus	Thick fog—fine.
	11		30.06		0.174	28	28		2.030				23	17			11			little	none	Stars bright.
17	10		30.00		0.162	26	26		1.897								11		ES	ditto	mist	Fine—sun blood-coloured.
	3		29.99		0.144	32	23	9	1.650	1.698	2.317	32						0.22		ditto	none	Cloudless day.
	11		29.99	— 0.21	0.139	26	22	4	1.628	1.642	1.897		21	16			10	0.09		ditto	none	Stars bright—very clear.
18	10		30.00	+ 0.01	0.162	28	26	2	1.890	1.897	2.030						10	0.08	E	brisk	cumulo-stratus	Hoar-frost—fine—overcast.
	4		29.99	— 0.01	0.186	33	30	3	2.150	2.162	2.393	33						0.12		ditto	ditto and stratus	Cold and bleak.
	11		30.00		0.180	31	29	2	2.089	2.096	2.240		30	27			12	0.06		ditto	overcast	Ditto ditto—dull.
19	10		30.02	+ 0.03	0.186	34	30	4	2.146	2.162	2.438	34					13	0.16	NE	ditto	stratus	Cold, bleak, and clear.
	4		29.99		0.193	33	31	2	2.231	2.240	2.393							0.08		ditto	ditto and scud	Ditto ditto—flakes of snow.
	11		29.94		0.200	32	32		2.317				22	18			14			ditto	overcast	Some snow—dull.
20	10		29.80		0.200	32	32		2.317								14			little	stratus	Deep fall of snow.
	3		29.79	— 0.23	0.200	32	32		2.317			32							SE	brisk	ditto	Snow all day.
	11	☽	29.83	+ 0.04	0.200	32	32		2.317				29	22			14			little	ditto	Dull.
21	10		29.78		0.193	32	31	1	2.235	2.240	2.317						20	0.03		ditto	mist	Fine—foggy.
	4		29.76		0.214	34	34		2.438											ditto	stratus	Dull—sleet.
	11		29.69	— 0.14	0.221	35	35		2.545			35	33	33			24			ditto	overcast	Rain.
22	10		29.75	+ 0.06	0.221	35	35		2.515								26		NE	ditto	stratus and mist	Rain—very foggy.
	4		29.69		0.283	42	42		3.214			42			0.42					brisk	cirri and fog	Sun red—hot and oppressive.
	11		29.64		0.273	41	41		3.106				39	38			27			ditto	light clouds	Moon and stars dim.
23	10		29.56		0.339	47	47		3.815			47					27		S	brisk	stratus and scud	Rain in the night—damp.
	4		29.49		0.328	46	46		3.699										SE	ditto	ditto ditto	Oppressive—rain.
	11		29.46		0.283	42	42		3.214				37	36			24			little	overcast	Damp and mild.
24	10		29.39		0.254	39	39		2.900			39					21		SW	ditto	stratus	Damp—dull—rain.
	4		29.30		0.245	38	38		2.803						0.10			0.04	NW	brisk	ditto	Steady rain.
	11		29.30	— 0.45	0.221	36	35	1	2.538	2.545	2.629		35	34			22			ditto	overcast	Moon rarely visible.
25	10		29.35		0.229	36	36		2.629								19		NE	stormy	stratus and scud	Small rain.
	4		29.49		0.254	39	39		2.900			39			0.07				E	ditto	ditto ditto	Squalls and rain.
	11		29.70		0.221	35	35		2.545				34	33			16			ditto	ditto ditto	Ditto ditto.
26	10		29.86		0.221	35	35		2.545			35					15		NE	ditto	ditto ditto	Ditto ditto.
	4		29.93		0.186	33	30	3	2.150	2.162	2.393				0.02			0.13		ditto	ditto and cumulo-stratus	Very squally.
	11		30.00		0.174	30	28	2	2.023	2.030	2.162		30	28			13	0.07		high	light scud	Moon-light—stars bright.

METEOROLOGICAL JOURNAL—*continued*.

Date. 1820.	Hour.	Moon's Age.	Pressure. Of the whole Atmosphere.	Pressure. Continuous rise and fall of Barometer.	Pressure. Of the Vapour.	Temperature. Of the Air.	Temperature. Of the Vapour.	Temperature. Difference.	Weight in grs. of Vapour in the space of a cubic foot. As expanded by the existing temperature.	Weight in grs. of Vapour. Maximum at the temperature of the Vapour.	Weight in grs. of Vapour. Maximum at the temperature of the Air.	Temperature. Highest.	Temperature. Lowest.	Temperature. Of a good radiator on the ground.	Quantity of rain.	De Luc's Hygrometer. Dry.	De Luc's Hygrometer. Moist.	Force in grs. of evaporation: from a surface 6 ins. diameter.	Wind. Direction.	Wind. Force	Prevailing Clouds.	Observations.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	14	15	17		18	19	20	21	22
Feb. 27	10		30.01	+0.71	0.162	35	26	9	1.865	1.897	2.545	..	..	....	....	..	11	0.37	....	high	cumulo-strati	Fine—intensely cold.
	3		29.97	−0.04	0.168	35	27	8	1.931	1.959	2.545	35	..	....	....	..	..	0.34	....	ditto	ditto and cirro-cumuli	Ditto—ditto.
	11	○	29.99	+0.02	0.180	29	29	..	2.096	....	....	..	28	24	....	..	12	....	....	little	few cirri	Nearly cloudless,
28	10		29.90	....	0.186	35	30	5	2.141	2.162	2.545	..	..	....	....	..	13	0.19	E	brisk	ditto ditto	Beautiful clear morning.
	4		29.83	....	0.186	36	30	6	2.135	2.162	2.629	36	..	....	....	..	..	0.23	....	ditto	cirri and light stratus	Very fine.
	11		29.83	....	0.162	29	26	3	1.886	1.897	2.096	..	28	20	....	..	13	0.11	....	ditto	none	Moon and stars bright.
29	10		29.77	....	0.180	29	29	..	2.096	....	....	..	..	....	....	..	13	....	SW	little	mist	Fine, but misty.
	3		29.68	....	0.207	38	33	5	2.369	2.393	2.803	38	..	....	....	..	..	0.15	W	ditto	none	Cloudless day.
	11		29.51	....	0.221	36	35	1	2.538	2.545	2.629	..	34	31	0.02	..	13	0.02	....	ditto	overcast	Mild—some rain.
Mar. 1	10		29.49	−50	0.207	43	33	10	2.350	2.393	3.326	43	..	....	....	..	13	0.55	NW	high	cumulo-strati few	Very fine and fresh.
	4		29.51	+02	0.186	42	30	12	2.112	2.162	3.214	..	..	....	....	..	..	0.50	....	brisk	ditto overcast	Fine and clear all day.
	11		29.41	....	0.193	38	31	7	2.209	2.240	2.803	..	32	28	....	..	12	0.21	....	little	overcast	Dull—very stormy.
2	10		29.00	−51	0.174	35	28	7	2.003	2.030	2.545	..	..	....	.04	..	11	0.29	N	stormy	cumulo-stratus	Very stormy—a little snow.
	4		29.13	....	0.129	35	20	15	1.467	1.529	2.545	35	..	....	....	..	..	0.57	....	ditto	ditto cirri, and cumuli	Very fine—wind cutting.
	12		29.46	....	0,162	29	26	3	1.887	1.897	2.096	..	28	28	....	..	10	0.11	....	ditto	a little scud	Snow storm—very fine and clear.
3	10		29.68	....	0.168	33	27	6	1.937	1.959	2.393	..	..	....	....	..	9	0.25	NE	high	cirri and scud	Very fine—air very transparent.
	4		29.76	....	0.168	34	27	7	1.935	1.959	2.438	34	..	....	....	..	..	0.30	....	very high	ditto and cumuli	Ditto—ditto—cutting.
	11		29.90	....	0.156	28	25	3	1.806	1.831	2.030	..	27	25	....	..	10	0.11	....	brisk	light scud	Very fine—stars and moon very bright.
4	10		29.91	+91	0.168	35	27	8	1.931	1.959	2.545	..	..	....	....	..	10	0.28	NE	ditto	cirri and cirro-strati	Very fine.
	4		29.89	−11	0.207	31	33	1	2.389	2.393	2.438	36	..	....	....	..	..	0.04	....	ditto	cumuli and nimbi	Ditto—very light snow showers.
	11		29.96	....	0.180	29	29	..	2.096	....	....	..	26	22	....	..	9	....	....	little	light clouds	Stars dim.
5	10		30.12	....	0.150	33	24	9	1.734	1.763	2.393	33	..	....	....	..	8	0.31	NE	high	little scud	Very clear and fine,
	4		30.13	....	0.124	32	19	13	1.437	1.474	2.317	..	..	....	....	..	..	0.47	....	ditto	ditto and cumuli	Beautiful day—very cutting.
	11		30.13	+33	0.134	25	21	4	1.572	1.586	1.831	..	25	18	....	..	9	0.12	....	little	none	Stars bright.
6	10		30.08	....	0.168	33	27	6	1.937	1.959	1.763	..	..	....	....	..	9	0.21	NE	brisk	stratus and scud	Bleak, cold, and dull—stellated snow.
	4		30.06	−07	0.131	33	21	12	1.549	1.586	1.763	33	..	....	....	..	..	0.38	....	ditto	cumulo-stratus	Fine, but bleak.
	12		30.10	+04	0.150	26	24	2	1.756	1.763	1.897	..	24	18	....	.	8	0.05	....	little	overcast	Dull and cold.
7	10		30.09	....	0.134	35	21	14	1.543	1.586	2.545	..	..	....	....	..	8	0.36	....	ditto	stratus	Overcast, but the air perfectly transparent.
	4		30.03	−07	0.221	35	35	..	2.545	....	....	36	..	....	....	..	..	....	NW	ditto	ditto and fog	Very dull—some sleet.
	11	☽	30.07	....	0.200	33	32	1	2.312	2.317	2.393	..	33	....	.03	..	10	0.02	....	ditto	overcast	Very dull—sleet.
8	10		30.16	+13	0.200	36	32	4	2.298	2.317	2.629	..	..	32	....	..	13	0.06	NE	ditto	cumulo-stratus and scud	Fine.
	4		30.14	−02	0.174	38	28	10	1.990	2.030	2.803	39	..	....	....	..	..	0.28	....	ditto	few cirri	Very fine—air very transparent.
	11		30.16	+02	0.186	30	30	..	2.162	....	....	..	27	....	....	..	13	....	....	ditto	none	Fine—foggy smell.
9	10		30.09	....	0.200	36	32	4	2.298	2.317	2.629	..	..	21	....	..	12	0.12	W	ditto	haze	Very fine, but hazy.
	4		30.01	....	0.214	42	34	8	2.400	2.438	3.214	43	..	....	....	..	..	0.27	SW	ditto	ditto	Ditto ditto.
	11		29.93	....	0.193	31	31	..	2.240	....	....	..	29	20	....	..	13	....	....	ditto	none	Very fine.
10	10		29.79	....	0.200	36	32	4	2.298	2.317	2.629	..	..	....	....	..	12	0.12	S	ditto	stratus and haze	Fine.
	4		29.63	....	0.193	41	31	10	2.196	2.240	3.106	42	..	....	....	..	..	0.32	....	ditto	none	Beautiful day.

	11		29.50	....	0.193	31	31	..	2.240	....	....	..	30	26	....	..	12	....	....	ditto	none	Beautiful night—great deposition of moisture.
11	10		29.57	....	0.221	38	36	2	2.619	2.629	2.803	..	..	....	....	..	13	0.08	SE	brisk	haze	Very fine.
	4		29.51	....	0.221	48	35	13	2.480	2.545	3.940	50	..	....	....	..	..	0.66	....	ditto	light haze	Beautiful day—cloudless.
	11		29.49	....	0.221	35	35	..	2.545	....	....	..	32	29	....	..	12	....	....	little	none	Very fine—great deposition.
12	10		29.40	....	0.237	38	37	1	2.711	2.717	2.803	..	..	....	.12	..	12	0.04	....	brisk	haze and scud	Early showers—fine.
	3		29.36	....	0.229	42	36	6	2.592	2.629	3.214	44	..	....	....	..	..	0.33	....	high	cirri	Very fine.
	..		29.36	− 80	0.245	38	38	..	2.803	.. .	....	..	35	32	....	..	13	....	....	little	overcast	Dull and mild.
13	10		29.56	....	0.254	45	39	6	2.877	2.900	3.570	..	.	....	....	..	13	0.24	W	ditto	cirro-cumuli, scud and haze	Very fine—great deposition.
	4		29.68	....	0.214	48	34	14	2.371	2.438	3.940	50	..	....	....	..	..	0.69	....	brisk	cumuli	Beautiful day.
	11		29.85	....	0.237	37	37	..	2.717	....	....	..	34	27	....	..	14	....	....	little	none	Stars bright.
14	10		30.01	....	0.316	48	45	3	2.548	3.570	3.940	..	..	....	....	..	16	0.14	SW	ditto	light stratus and haze	Fine, but hazy.
	4	●	30.07	....	0.388	53	51	2	4.315	4.330	4.616	56	..	....	....	..	..	0.14	....	brisk	stratus and haze	Overcast all day—close.
	11		30.13	....	0.363	49	49	..	4.068	....	...	..	48	43	....	..	18	....	....	little	overcast	Dull—close and oppressive.
15	10		30.10	+ 63	0.388	58	51	7	4.276	4.330	5.402	..	..	....	....	..	19	0.41	....	ditto	cirro-cumuli.	Fine spring day.
	4		30.18	− 01	0.388	59	51	8	4.260	4.330	5.570	61	..	....	....	..	..	0.48	....	brisk	ditto	Very fine.
	11		30.22	....	0.388	51	51	..	4.330	....	....	..	44	42	....	..	18	....	....	ditto	overcast	Very close and oppressive.
16	10		30.29	+ 11	0.328	48	46	2	3.683	3.699	3.940	..	..	....	....	..	17	0.09	SE	little	stratus and mist	Dull and misty.
	5		30.24	....	0.273	49	41	8	3.057	3.106	4.068	52	..	....	....	..	..	0.77	SE	brisk	cumulo-stratus	Afternoon very fine.
	11		30.23	....	0.245	39	38	1	2.798	2.803	2.900	..	36	32	....	..	15	0.05	....	ditto	none	Stars bright.
17	10		30.16	....	0.283	44	42	2	3.203	3.214	3.452	..	..	....	.01	..	14	0.09	....	little	stratus and mist	A little rain—dull—fog.
	4		30.16	− 13	0.328	50	46	4	3.669	3.699	4.195	51	..	....	....	..	..	0.30	NE	high	cumulo-stratus	Afternoon fine.
	11		30.23	....	0.273	41	41	..	3.106	....	....	..	34	30	....	..	12	....	....	brisk	ditto	Stars dull—some clouds—some sleet.
18	10		30.26	+ 10	0.229	42	36	6	2.600	2.629	3.214	..	..	....	....	..	10	0.27	N	ditto	ditto	Very fine.
	4		30.21	....	0.162	45	26	19	1.830	1.897	3.570	47	..	....	....	..	..	0.80	NE	ditto	ditto and cirro-cumuli	Very fine and clear.
	11		30.20	....	0.221	37	35	2	2.534	2.545	2.717	..	35	. ..	....	..	10	0.08	....	ditto	light	Stars dull.
19	10		30.14	....	0.237	42	37	5	2.692	2.717	3.214	..	..	....	....	.	9	0.23	E	ditto	cumulo-stratus	Lowering and dull.
	4		30.11	− 15	0.207	44	33	11	2.342	2.393	3.452	45	.	....	....	..	..	0.50	....	ditto	ditto	Ditto ditto—fine, but dull.
	11		30.16	....	0.180	37	29	8	2.067	2.096	2.717		35	33	....	..	9	0.36	....	high	overcast	Dull and windy.
20	10		30.16	+ 05	0.221	39	35	4	2.524	2.545	2.900	..	..	....	....	..	9	0.12	....	little	cumulo-stratus and stratus..	Grey, but clear.
	4	☽	30.13	....	0.237	46	37	9	2.672	2.717	3.699	47	..	....	..	..	..	0.36	NE	ditto	cumulo-stratus	Ditto ditto.
	11		30.13	....	0.221	35	35	..	2.515	....	.. .	..	35	28	....	..	8	....	....	ditto	none	Stars clear.
21	10		30.06	....	0.221	45	35	10	2.496	2.545	3.570	..	.	....	. ..	..	8	0.36	NW	ditto	cumulo-stratus and haze...	Fine, but hazy.
	5		29.93	....	0.237	48	37	11	2.661	2.717	3.940	49	.	....	..	..	..	0.45	....	ditto	ditto ditto	Ditto ditto.
	11		29.85	....	0.254	41	39	2	2.889	2.900	3.106	..	39	35	.01	..	9	0.07	....	ditto	overcast	Dull—some rain.
22	10		29.74	....	0.221	47	35	12	2.485	2.545	3.815	.	..	....	....	..	9	0.61	NE	brisk	small cumuli	Fine—fresh and clear.
	5		29.71	....	0.207	50	33	17	2.317	2.393	4.195	50	.	....	....	..	..	0.85	N	ditto	cirri and cirro-cumuli	Very fine—exhilarating.
	11		29.53	....	0.328	46	46	..	3.699	...	....	..	44	42	.02	..	8	....	NWW	ditto	overcast	Small steady rain.
3	10		29.30	....	0.283	49	42	7	3.171	3.214	4.068	..	..	....	....	..	9	0.41	W	ditto	cirro-cumuli, scud, and haze	Fine—sun at intervals.
	4		29.09	....	0.229	50	36	14	2.565	2.629	4.195	50	..	....	....	..	..	0.91	NW	high	cirro-cumuli and cumuli....	Fine—sharp shower—fine.
	11		29.04	....	0.229	41	36	5	2.605	2.629	3.106	..	38	36	....	..	7	0.26	....	ditto	light clouds	Moon and stars bright.
24	10		29.02	....	0.229	48	36	12	2.570	2.629	3.940	..	..	....	....	..	7	0.62	NW	brisk	cumuli and cumulo-strati ..	Fine.
	4		28.87	....	0.237	48	37	11	2.660	2.717	3.940	48	..	....	....	..	..	0.58	W	ditto	cumulo-stratus&stratus--haze	Ditto—light showers—fine.
	11		28.87	−1.29	0.245	38	38	..	2.803	....	....	..	33	29	...	..	6	....	....	ditto	overcast	Clouds light—moon visible.
25	10		29.21	....	0.186	42	30	12	2.103	2.162	3.214	..	..	....	....	..	5	0.50	NE	ditto	cumulo-strati	Beautiful bright morning.
	4		29.33	....	0.144	46	23	23	1.624	1.698	3.699	46	..	....	....	..	..	0.95	N	ditto	ditto and cumuli	Ditto ditto.
	11		29.56	....	0.200	33	32	1	2.313	2.317	2.393	..	28	22	....	..	6	0.03	....	little	none	Moon and stars bright and sharp.
26	10		29.67	+ 80	0.186	45	30	15	2.101	2.162	3.570	..	..	....	....	..	3	0.52	W	ditto	light stratus..	Sun rose very clear—overcast.
	4		29.60	− 07	0.316	45	45	..	3.570	....	....	..	..	....	.02	..	..	....	SW	ditto	stratus	Light steady rain.
	11		29.64	....	0.351	48	48	..	3.940	....	....	48	44	44	....	..	18	....	....	ditto	overcast	Very damp—foggy smell—rain.
27	10		29.74	+0.14	0.363	53	49	4	4.041	4.068	4.616	..	..	....	....	..	19	0.21	SW	little	stratus and scud	Mild and damp—small rain.
	4		29.72	−0.02	0.375	54	50	4	4.165	4.195	4.770	54	..	....	.01	..	..	0.28	....	brisk	ditto ditto	Ditto ditto—small rain at intervals.
	11		29.76	....	0.375	50	50	..	4.195	....	....	..	44	41	....	..	17	....	....	ditto	ditto ditto	Small rain.
28	10		29.92	....	0.363	55	49	6	4.025	4.068	4.910	..	..	....	....	..	17	0.32	W	little	cumulo-stratus and scud...	Mild—clouds breaking.
	4		29.91	....	0.351	56	48	8	3.884	3.940	5.068	57	..	....	....	..	..	0.55	SW	brisk	cirri	Very fine.
	11		29.99	....	0.375	50	50	..	4.195	...	....	..	48	44	....	..	16	..	....	little	overcast	Damp and close.
29	10		30.03	+0.27	0.363	56	49	7	4.018	4.068	5.068	..	..	....	....	..	15	0.49	W	brisk	light stratus	Grey, but fine.
	4		29.99	....	0.401	59	52	7	4.405	4.468	5.570	60	..	....	....	..	..	0.55	SW	ditto	cumulo-stratus	Very fine.
	11	○	29.92	....	0.363	49	49	..	4.068	...	....	..	41	35	....	..	15	..	....	little	none	Cloudless night.
30	10		29.88	....	0.351	53	48	5	3.905	3.940	4.616	..	..	....	....	..	13	0.26	....	ditto	cirro-cumuli&cumulo-strati	Fine and mild.
	4		29.88	−0.15	0.429	59	54	5	4.719	4.770	5.570	60	..	....	....	..	..	0.32	....	ditto	cirri and cirro-cumuli	Fine.
	11		29.91	....	0.254	44	39	5	2.383	2.900	3.452	..	33	27	....	..	11	0.20	NW	calm	none	Beautiful clear moon.

METEOROLOGICAL JOURNAL—*continued.*

Date. 1820.	Hour.	Moon's Age.	Pressure. Of the whole Atmosphere.	Pressure. Continuous rise and fall of Barometer.	Pressure. Of the Vapour.	Temperature. Of the Air.	Temperature. Of the Vapour.	Temperature. Difference.	Weight in grs. of Vapour in the space of a cubic foot. As expanded by the existing temperature.	Weight in grs. of Vapour in the space of a cubic foot. Maximum at the temperature of the Vapour.	Weight in grs. of Vapour in the space of a cubic foot. Maximum at the temperature of the Air.	Temperature. Highest.	Temperature. Lowest.	Temperature. Of a good radiator on the ground.	Quantity of rain.	De Luc's Hygrometer. Dry.	De Luc's Hygrometer. Moist.	Force of evaporation in grs., from a surface 6 ins. diameter.	Wind. Direction.	Wind. Force.	Prevailing Clouds.	Observations.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		18	19	20	21	22
Mar. 31	9		29.91	+0.03	0.283	50	42	8	3.161	3.214	4.195	..	..	....	....	..	9	0.37	....	calm	small cumuli	Fine—deposition of moisture.
	4		29.88	—0.03	0.237	58	37	21	2.611	2.717	5.402	60	..	....	....	..	..	1.01	NE	little	none	Perfectly fine.
	10		29.92	....	0.305	47	44	3	3.433	3.452	3.815	..	37	31	....	..	17	0.14	NW	ditto	cirrus	Very fine.
Apr. 1	10		30.06	+0.18	0.283	51	42	9	3.159	3.214	4.330	..	..	....	....	..	18	0.66	W	high	cirri and stratus	Overcast.
	4		30.02	—0.04	0.351	56	48	8	3.881	3.940	5.068	59	..	....	....	..	..	0.68	....	ditto	cumulo-stratus and scud	Ditto.
	10		30.07	....	0.375	50	50	..	4.195	....	....	..	44	41	....	..	16	....	....	brisk	overcast	Very dark.
2	10		30.10	....	0.401	55	52	3	4.414	4.468	4.910	..	..	....	....	..	14	0.22	NW	ditto	ditto	Dull.
	4		30.10	....	0.415	63	53	7	4.530	4.616	6.310	64	..	....	....	..	..	0.65	....	little	cumulo-stratus	Heavy, with some breaks.
	10		30.12	....	0.375	51	50	1	4.188	4.195	4.330	..	49	45	....	..	12	0.05	....	ditto	overcast	Dark—few stars.
3	10		30.21	....	0.415	60	53	7	4.555	4.616	5.761	..	..	....	....	..	10	0.44	N	ditto	cumulo-stratus and mist	Dull.
	4		30.21	+0.19	0.415	60	53	7	4.555	4.616	5.761	63	..	....	....	..	..	0.41	S	ditto	ditto ditto	Very gloomy.
	10		30.20	....	0.339	47	47	..	3.815	....	....	..	36	32	....	..	10	....	....	ditto	few	Fine.
4	10		30.04	....	0.263	52	40	10	2.931	2.999	4.468	..	..	....	....	..	9	0.55	E	ditto	cirro-stratus	Fine.
	4		29.96	....	0.388	60	51	9	4.255	4.330	5.761	60	..	....	....	..	..	0.55	....	ditto	ditto	Ditto.
	10		29.94	....	0.245	45	38	7	2.768	2.803	3.570	..	37	34	....	..	4	0.28	....	ditto	none	Very fine.
5	10		29.85	....	0.273	53	41	12	3.043	3.106	4.616	..	..	....	....	..	3	0.57	....	calm	cirro-cumulus and haze	Fine
	5		29.78	....	0.294	64	43	21	3.195	3.326	6.506	66	..	....	....	..	..	1.21	SW	little	cirro-stratus	Very clear and fine.
	10		29.77	....	0.283	50	42	8	3.164	3.214	4.195	..	41	41	....	..	1	0.37	....	calm	cumulo-stratus	Stars dim.
6	10	☾	29.49	....	0.316	47	45	[illegible]	3.557	3.570	3.815	..	..	....	....	..	6	0.10	....	little	stratus	Gentle rain.
	4		29.46	....	0.328	49	46	3	3.676	3.699	4.068	52	..	....	....	..	..	0.14	NW	ditto	ditto and cumulo-stratus	Showers.
	10		29.46	—0.75	0.214	36	34	2	2.427	2.438	2.629	..	30	27	.17	..	7	0.06	....	ditto	none	Very clear.
7	10		29.52	....	0.200	43	32	11	2.267	2.317	3.326	..	..	....	....	..	7	0.45	SW	brisk	cumuli and cirro-cumuli	Low cumuli moving quick—high cirro-cumuli stationary.
	4		29.51	....	0.273	46	41	5	3.077	3.106	3.699	50	..	....	.02	..	..	0.22	....	little	ditto ditto	Light shower.
	10		29.55	+0.09	0.237	37	37	..	2.717	....	....	..	30	25	....	..	9	....	....	ditto	cumulo-stratus	Very fine.
8	10		29.44	....	0.237	48	37	11	2.660	2.717	3.940	..	..	....	....	..	7	0.45	....	ditto	cirri and cumuli	Fine.
	4		29.43	....	0.273	49	41	8	3.057	3.106	4.068	52	..	....	....	..	..	0.36	SE	ditto	stratus and cumuli	Showers,
	10		29.20	—0.35	0.305	44	44	..	3.452	....	....	..	42	41	.12	..	6	....	....	calm	overcast	Rain.
9	10		29.37	....	0.263	42	40	2	2.988	2.999	3.214	..	..	....	....	..	6	0.10	NW	brisk	stratus	Showers.
	4		29.44	....	0.229	51	36	15	2.555	2.629	4.330	52	..	....	....	..	..	0.63	....	little	cumulo-stratus	Very light showers.
	10		29.51	....	0.245	38	38	..	2.803	....	....	..	29	23	....	..	6	....	....	ditto	few	Very fine.
10	10		29.54	+0.34	0.283	49	42	7	3.171	3.214	4.068	..	..	....	....	..	7	0.32	....	ditto	cumulo-stratus	Very dark.
	4		29.49	....	0.363	49	49	..	4.068	....	....	49	..	....	.26	..	..	....	S	brisk	stratus	Hard steady rain.
	11		29.49	—0.05	0.351	48	48	..	3.940	....	....	..	46	46	....	..	11	....	....	little	overcast	Dull and damp.
11	10		29.62	....	0.363	50	49	1	4.061	4.068	4.195	..	..	....	....	..	15	0.06	SW	brisk	stratus and scud	Damp clouds breaking.
	4		29.61	....	0.388	55	51	4	4.299	4.330	4.910	59	..	....	....	..	..	0.29	....	ditto	ditto ditto	Sharp showers.
	11		29.62	....	0.351	48	48	..	3.940	....	....	..	46	40	....	..	14	....	....	little	overcast	Hard rain.
12	9		29.89	+0.40	0.363	50	49	1	4.061	4.068	4.195	..	..	....	....	..	14	0.06	SW	ditto	stratus and mist	Mild, damp, and overcast.
	4		29.87	—0.02	0.363	55	49	6	4.150	4.195	4.910	58	..	....	....	..	..	0.32	....	ditto	ditto ditto	Much rain, and oppressive.

	11	●	30.02	+0.15	0.351	50	48	2	3.925	3.940	4.195	..	46	43	....	..	14	0.10	....	ditto	overcast	Close and oppressive.
13	9		30.01	....	0.339	49	47	2	3.798	3.815	4.068	..	..	....	....	..	11	0.09	SE	ditto	stratus	Overcast.
	4		30.00	....	0.363	50	49	1	4.061	4.068	4.195	50	..	....	·35	..	..	0.06	....	....	ditto	Hard rain—oppressive.
	11		29.84	....	0.351	48	48	..	3.940	....	....	..	46	....	·45	..	15	....	....	ditto	overcast	Much rain.
14	9		29.79	....	0.363	50	49	1	4.061	4.068	4.195	..	..	....	....	..	16	0.06	....	ditto	stratus and mist	Damp and dull.
	4		29.65	−0.37	0.363	50	49	1	4.061	4.068	4.195	50	..	....	....	..	..	0.06	....	calm	ditto and fog	Dense fog—hard rain.
	11		29.73	....	0.328	46	46	..	3.699	....	....	..	39	34	....	..	14	....	....	ditto	overcast	Damp—rainy and very oppressive.
15	10		29.81	....	0.273	55	41	14	3.025	3.106	4.910	..	..	....	....	..	13	0.68	NW	little	small cumulo-strati	Beautiful clear morning.
	4		29.87	....	0.273	56	41	15	3.018	3.106	5.068	57	..	....	....	..	..	0.74	....	ditto	cumuli and ditto	Very fine—clouds heavy.
	11		30.01	....	0.254	43	39	4	2.879	2.900	3.326	..	40	35	....	..	11	0.16	....	ditto	none	Stars perfectly bright.
16	10		30.10	....	0.263	58	40	18	2.906	2.999	5.402	..	..	....	....	..	10	0.91	NW	ditto	cirri and haze	Very fine.
	4		30.22	....	0.363	61	49	11	3.980	4.068	5.950	63	..	....	....	..	..	0.72	....	ditto	cumulo-strati	Very fine—overcast at four.
	11		30.33	....	0.375	51	50	1	4.188	4.195	4.330	..	43	39	....	..	12	0.05	....	ditto	very light	Very fine—oppressive.
17	10		30.36	+0.71	0.415	64	53	11	4.523	4.616	6.506	..	..	....	....	..	14	0.73	NW	ditto	cumulo-strati and haze	Very fine—close.
	4		30.33	....	0.401	65	52	13	4.362	4.468	6.614	67	..	....	....	..	..	1.10	....	brisk	ditto	Very fine.
	10		30.32	....	0.388	53	51	2	4.315	4.330	4.616	..	44	39	....	..	13	0.11	....	little	none	Very fine.
18	10		30.22	....	0.401	58	52	6	4.420	4.468	5.402	..	..	....	....	..	15	0.36	SE	little	haze	Very fine.
	4		30.15	−0.21	0.388	62	51	11	4.242	4.330	6.126	66	..	....	....	..	..	0.69	....	ditto	ditto	Very fine.
	11		30.16	....	0.351	48	48	..	3.940	....	....	..	43	37	....	..	14	....	....	ditto	none	Very fine.
19	10		30.20	+0.05	0.388	62	51	11	4.242	4.330	6.126	..	..	....	....	..	12	0.69	NE	ditto	very light haze	Cloudless.
	4		30.17	....	0.328	67	46	21	3.556	3.699	7.013	67	..	....	....	..	..	1.31	NW	ditto	ditto and small cumuli	Very fine.
	11		30.13	−0.07	0.328	54	46	8	3.643	3.699	4.770	..	45	41	....	..	11	0.40	....	ditto	light cirri	Fine—moon a little hazy.
20	10	☽	30.19	....	0.328	61	46	15	3.595	3.699	5.950	..	..	....	....	..	10	0.86	N	ditto	cumulo-strati	Very fine.
	4		30.23	....	0.294	62	43	19	3.207	3.326	6.126	64	..	....	....	..	..	1.06	....	ditto	ditto and strati	Ditto sometimes covered.
	11		30.28	....	0.283	48	42	6	3.177	3.214	3.940	..	41	35	....	..	10	0.35	....	brisk	none	Very fine.
21	10		30.30	+0.17	0.305	59	44	15	3.353	3.452	5.570	..	..	....	....	..	9	0.81	NE	little	very light cirri	Nearly cloudless.
	4		30.29	−0.01	0.305	62	44	18	3.335	3.452	6.126	67	..	....	....	..	..	1.31	....	brisk	cumulo-strati	Very fine.
	11		30.33	....	0.363	49	49	..	4.068	....	....	..	41	36	....	..	11	....	SE	little	none	Very fine.
22	10		30.50	+0.21	0.305	59	44	15	3.353	3.452	5.570	..	..	....	....	..	8	1.04	E	brisk	none	Cloudless day—fresh.
	4		30.38	−0.12	0.305	60	44	16	3.348	3.452	5.761	63	..	....	....	..	..	1.13	....	ditto	none	Cloudless—exhilarating.
	11		30.50	+0.12	0.294	47	43	4	3.302	3.326	3.815	..	39	36	....	..	10	0.18	....	little	none	Moon perfectly clear.
23	10		30.45	....	0.316	58	45	13	3.484	3.570	5.402	..	..	....	....	..	9	0.90	E	brisk	cirri and small cirro-cumuli	Very fine.
	4		30.45	−0.05	0.305	60	44	16	3.348	3.452	5.761	62	..	....	....	..	..	1.38	....	high	none	Cloudless day.
	11		30.50	+0.05	0.273	46	41	5	3.077	3.106	3.699	..	40	36	....	..	8	0.28	....	brisk	cirri	Very fine.
24	10		30.49	−0.01	0.316	55	45	10	3.503	3.570	4.910	..	..	....	....	..	8	0.79	NE	high	none	Very fine.
	4		30.51	....	0.254	62	39	23	2.776	2.900	6.126	64	..	....	....	..	..	1.92	....	ditto	cirri few	Very fine.
	11		30.54	+0.05	0.263	45	40	5	2.973	2.999	3.570	..	38	33	....	..	7	0.27	....	brisk	none	Very fine.
25	10		30.38	−0.16	0.283	52	42	10	3.153	3.214	4.468	..	..	....	....	..	6	0.73	NE	high	cumulo-strati and scud	Fine.
	4		30.39	+0.01	0.214	60	34	26	2.319	2.438	5.761	64	..	....	....	..	..	1.59	....	brisk	none	Very fine.
	11		30.32	....	0.283	44	42	2	3.202	3.214	3.452	..	37	29	....	..	7	0.09	....	little	none	Very fine.
26	10		30.10	....	0.305	64	44	20	3.324	3.452	6.506	..	..	....	....	..	7	1.17	W	little	cirri and haze	Very fine.
	4		29.80	....	0.305	56	44	12	3.375	3.452	5.068	67	..	....	0.10	..	..	0.61	N	ditto	stratus and cumulo-stratus	Overcast.
	11		29.66	−0.73	0.294	47	43	4	3.302	3.326	3.815	..	41	38	....	..	8	0.18	....	ditto	ditto ditto	Ditto.
27	9		29.71	....	0.294	43	43	..	3.326	....	....	..	..	....	....	..	10	....	NE	stormy	stratus and scud	Overcast—showers.
	5		29.83	....	0.207	42	33	9	2.352	2.393	3.214	47	..	....	....	..	..	0.48	....	high	ditto ditto	Overcast—cold and raw.
	11		29.91	....	0.221	39	35	4	2.524	2.545	2.000	..	38	36	....	..	8	0.12	....	little	overcast	Dull and cold.
28	10	○	30.01	....	0.168	50	27	23	1.872	1.959	4.195	..	..	....	....	..	6	0.83	NE	ditto	cumulo-stratus	Fine—clouds breaking.
	4		30.01	....	0.207	51	33	18	2.313	2.393	4.330	53	..	....	....	..	..	0.72	NW	ditto	ditto small	Very fine—fresh.
	11		30.03	....	0.207	40	33	7	2.360	2.393	2.999	..	36	28	....	..	7	0.22	....	ditto	haze	Very fine.
29	10		30.10	....	0.337	55	37	18	2.625	2.717	4.910	..	..	....	....	..	7	0.82	NW	little	cumulo-strati and haze	Very fine.
	4		30.10	....	0.263	58	40	18	2.903	2.999	5.402	61	..	....	....	..	..	0.91	W	ditto	ditto ditto and stratus	Overcast.
	11		30.11	....	0.305	48	44	4	3.424	3.452	3.940	..	41	34	....	..	6	0.23	....	brisk	cumulo-stratus	Overcast.
30	10		30.18	....	0.339	56	47	9	3.750	3.815	5.068	..	..	....	0.20	..	8	0.47	....	calm	ditto and stratus	Slight showers—fine
	4		30.22	....	0.207	56	33	23	2.293	2.393	5.068	59	..	....	....	..	..	1.28	NE	brisk	cumulo-stratus and cirri	Very fine—fresh.
	11		30.27	....	0.207	44	33	11	2.345	2.393	3.452	..	36	28	....	..	5	0.39	NW	little	none	Very fine.
May 1	10		30.31	....	0.273	56	41	15	3.018	3.106	5.068	..	..	....	....	..	7	0.74	NW	ditto	cirro-cumuli, haze & cumuli	Very fine
	4		30.33	....	0.229	56	36	20	2.533	2.629	5.068	62	..	....	....	..	..	1.17	....	brisk	ditto few	Very fine.
	11		30.33	+0.67	0.273	46	41	5	3.077	3.106	3.699	..	40	33	....	..	8	0.28	....	ditto	overcast	Dull and dark.
2	10		30.27	....	0.283	58	42	16	3.118	3.214	5.402	..	..	....	....	..	7	0.83	NW	little	thin stratus	Thinly overcast.
	5		30.16	....	0.273	57	41	16	3.014	3.106	5.235	65	..	....	....	..	..	0.81	SE	ditto	stratus and haze	Fine.
	11		30.14	....	0.273	48	41	7	3.064	3.106	3.940	..	42	39	....	..	8	0.31	....	ditto	cumulo-stratus	Dull—few stars.

METEOROLOGICAL JOURNAL—*continued.*

Date.	Hour.	Moon's Age.	Pressure.			Temperature.			Weight in grs. of Vapour in the space of a cubic foot.			Temperature.			Quantity of rain.	De Luc's Hygrometer.		Force of evaporation in grs. from a surface 6 ins. diameter.	WIND.		PREVAILING CLOUDS.	OBSERVATIONS.
1820.			Of the whole Atmosphere.	Continuous rise and fall of Barometer.	Of the Vapour.	Of the Air.	Of the Vapour.	Difference.	As expanded by the existing temperature.	Maximum at the temperature of the Vapour.	Maximum at the temperature of the Air.	Highest.	Lowest.	Of a good radiator on the ground.		Dry.	Moist.		Direction.	Force.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		18	19	20	21	22
May 3	10		30.15	....	0.283	45	42	3	3.196	3.214	3 570	..	..	....	....	..	9	0.13	E	little	stratus	Overcast and dull.
	4		30.10	....	0.294	50	43	7	3.281	3.326	4.195	51	..	....	....	..	..	0.32	SE	ditto	ditto ditto and haze	Ditto ditto.
	11		30.03	....	0.263	45	40	5	2.973	2.999	3.570	..	41	40	....	..	8	0.27	....	brisk	overcast	Ditto ditto.
4	10		29.95	....	0.207	49	33	16	2.322	2.393	4.068	..	..	....	....	..	7	0.79	E	ditto	light cumulo-strati	Shower in the night—very fine.
	4		29.88	....	0.221	53	35	18	2.458	2.545	4.616	54	..	....	....	..	..	0.99	....	ditto	ditto cirro-cumuli and haze	Fine—cold.
	11		29.86	— 0.47	0.237	42	37	5	2.692	2.717	3.214	..	33	28	....	..	8	0.23	....	ditto	stratus	Stars few and dull.
5	10		29.88	....	0.186	51	30	21	2.076	2.162	4.330	..	..	....	....	..	7	1.04	....	ditto	cumulo-stratus	Fine and very cold.
	4	☽	29.88	....	0.186	52	30	22	2.072	2.162	4.468	54	..	....	....	..	..	1.11	....	ditto	ditto	Ditto ditto.
	11		29.88	....	0.237	40	37	3	2.702	2.717	2.999	..	33	24	....	..	9	0.13	....	little	none	Very fine.
6	10		29.88	+ 0.02	0.237	59	37	22	2.604	2.717	5.570	..	..	....	....	.	9	1.39	W	brisk	cumuli and cumulo-strati	Very fine.
	4		29.79	....	0.254	60	39	21	2.787	2.900	5.761	64	..	....	....	..	..	1.39	SW	ditto	cumulo-strati and stratus	Overcast—still cold.
	11		29.67	....	0.294	46	43	3	3.308	3.326	3.699	..	45	41	....	..	10	0.17	....	ditto	overcast	Showers.
7	10		29.62	— 0.26	0.294	62	43	19	3.206	3.326	6.126	..	..	....	....	..	9	1.37	NW	ditto	cirri and cumulo-strati	Very fine.
	4		29.68	....	0.273	65	41	24	2.969	3.106	6.614	66	..	....	....	..	..	1.37	....	little	ditto ditto cirro-cumuli	Beautiful day—warmer.
	11		29.70	....	0.294	53	43	10	3.263	3.326	4.616	..	51	46	....	..	8	0.48	....	ditto	overcast	Dull and warm.
8	10		29.71	+ 0.09	0.415	62	53	9	4.539	4.616	6.126	..	..	....	....	..	9	0.75	SW	brisk	light stratus, haze&cum.-stra.	Light sprinklings of rain, and hazy sun.
	4		29.69	....	0:415	62	53	9	4.539	4.616	6.126	67	..	....	....	..	..	0.75	....	ditto	stratus and cumulo-stratus	Overcast and heavy—showers.
	11		29.64	— 0.07	0.429	54	54	..	4.770	....	....	..	51	47	....	..	10	....	....	little	overcast	Hard showers.
9	9		29 65	....	0.388	64	51	13	4.227	4.330	6 506	..	..	....	....	..	6	1.08	SW	brisk	stratus&cumulo-stratus(hazy)	Overcast, with gleams of sun.
	4		29.67	....	0.316	63	45	18	3.453	3.570	6.310	69	.	....	....	..	..	1.36	....	ditto	cumulo-strati&cumuli(hazy)	Very fine.
	11		29.67	....	0.363	51	49	2	4.053	4.068	4 330	..	46	42	....	..	4	0.13	....	ditto	none	Beautiful night.
10	10		29.80	....	0.351	68	48	20	3.800	3.940	7.316	..	..	....	...	..	1	2.04	SW	high	cumuli and cumulo-strati	Very fine.
	4		29.88	....	0.401	63	52	11	4.378	4.468	6.310	69	..	....	....	..	..	1.12	....	stormy	heavy cumulo-strati	Light sprinklings of rain.
	11		29.90	....	0.401	53	52	1	4.460	4.468	4.616	..	50	47	....	..	2	0.06	....	little	very light	Fine—star-light.
11	10		29.97	+ 0.33	0.375	65	50	15	4.080	4.195	6,614	..	..	....	...	..	2	1.01	W	high	cumulo-stratus and scud	Fine—very light sprinklings.
	4		29.96	— 0.01	0.316	65	45	20	3.440	3.570	6.614	69	..	....	...	..	..	1.38	....	ditto	cumulo-stratus	Very fine.
	11		30 00	....	0.328	51	46	5	3.622	3.699	4.330	..	47	41	....	..	6	0.68	....	brisk	none	Stars perfectly bright.
12	10	●	30.05	+ 0.09	0.328	65	46	19	3.569	3.699	6.614	..	..	....	....	..	6	1.48	SW	ditto	stratus&cumulo-stratus(haze)	Overcast—sun at intervals.
	4		30.02	....	0.339	67	47	20	3 674	3.815	7.013	70	..	....	....	..	..	1.63	....	ditto	cumuli, cumuli-strati & cirri	Very fine.
	11		30.01	....	0.415	53	53	..	4.616	....	....	..	43	36	..	..	8	....	....	little	stratus	Stars dull—close.
13	10		29.95	....	0 415	60	53	7	4.555	4.616	5.761	..	..	....	....	..	8	0.44	E	ditto	ditto haze	Very foggy at half-past four—dull.
	4		29.90	....	0.443	60	55	5	4.861	4.910	5.761	64	..	....	....	..	..	0.33	SE	ditto	ditto ditto	Light sprinklings of rain.
	11		29.88	....	0.415	53	53	..	4.616	....	....	..	51	49	....	..	7	....	....	ditto	stratus	Stars dim.
14	10		29.88	....	0.415	65	53	12	4.515	4.616	6.614	..	..	....	....	..	7	0.80	SW	ditto	light stratus and haze	Overcast but fine.
	4		29.82	....	0.351	65	48	17	3.818	3.940	6.614	70	..	....	....	..	..	1.06	....	ditto	cumulo-stratus and cumuli	Overcast and dull—a few drops of rain.
	11		29.82	— 0.23	0.363	52	49	3	4.046	4.068	4.468	..	46	41	....	..	6	0.20	....	brisk	light stratus	Fine.
15	10		29.83	+ 0.01	0.339	67	47	20	3.674	3.815	7.013	..	..	....	....	..	6	1.63	W	ditto	cumuli and cumulo-strati	Very fine—heat drops.
	4		29.80	....	0.305	66	44	22	3.313	3.452	6.912	70	..	....	....	..	..	1.70	....	ditto	ditto ditto and cirri	Very fine and fresh.

	12		29.74	....	0.429	54	54	..	4.770	....	....	..	49	49	....	..	7	....	....	little	overcast	Gentle rain.
16	10		29.70	−0.13	0.415	55	53	5	4.575	4.616	5.402	..	..	....	....	..	6	0.39	....	brisk	stratus and cumulo-stratus	Rain till eight o'clock—sun broke through.
	4		29.72	....	0.339	61	47	14	3.713	3.815	5.950	66	..	....	....	..	..	1.04	SW	ditto	cumuli and scud	Sharp showers—very fine.
	12		29.72	....	0.401	52	52	..	4.468	....	....	..	47	46	....	..	6	....	....	little	stratus	Steady rain, but gentle.
17	10		29.76	+0.06	0.363	65	49	16	3.966	4.068	6.614	..	..	....	....	..	8	1.30	....	brisk	cumulo-stratus	Fine.
	4		29.73	....	0.316	64	45	19	3.444	3.570	6.506	67	..	....	....	..	..	1.45	....	ditto	ditto and cumuli	Very fine.
	11		29.61	....	0.388	53	51	2	4.315	4.330	4.616	..	49	46	....	..	10	0.14	....	ditto	overcast	Dull—few stars very dim.
18	10		29.32	....	0.388	52	51	1	4.323	4.330	4.468	..	..	....	....	..	11	0.05	....	little	stratus	Hard rain till nine—clouds higher, and clearing.
	4		29.16	−0.56	0.401	56	52	4	4.435	3.468	5.068	60	..	....	....	..	..	0.37	....	stormy	stratus and scud	Sharp showers—very windy
	11		29.28	....	0.375	50	50	..	4.195	....	....	..	47	47	....	..	10	....	....	high	overcast	Hard rain.
19	10		29.72	....	0.339	69	47	22	3.662	3.815	7.541	..	..	....	....	..	9	1.84	....	brisk	cumuli and cumulo-strati	Very fine.
	4		29.81	....	0.328	64	46	18	3.576	3.699	6.506	70	..	....	....	..	..	1.39	....	ditto	ditto ditto	Very heavy shower, with hail—very fine.
	11		29.97	....	0.328	51	46	5	3.622	3.699	4.320	..	47	41	....	..	9	0.24	....	little	none	Stars and moon perfectly bright.
20	10	☽	30.15	....	0.458	68	56	12	4.957	5.068	7.316	..	..	....	....	..	..	1.12	....	brisk	stratus and cumulo-stratus	Very close and oppressive.
	4		30.25	....	0.429	66	54	12	4.665	4.770	6.912	68	..	....	....	..	..	1.07	....	ditto	large and black	Two strata—lower moving quickly.
	10		30.30	....	0.351	53	48	5	3.900	3.940	4.616	..	44	37	....	..	..	0.26	....	little	cirro-cumulus	Nearly cloudless.
21	10		30.32	+0.16	0.375	62	50	12	4.098	4.195	6.126	..	..	....	....	..	..	0.74	SWS	gentle	cirro-cumulus and cirrus	Fine, but cloudy.
	4		30.30	....	0.415	70	53	17	4.477	4.616	7.776	71	..	....	....	..	..	1.22	S	ditto	ditto and small cumuli	Fine—fewer clouds.
	10		30.29	....	0.363	52	49	3	4.046	4.068	4.468	..	47	40	....	..	..	0.15	....	calm	halo round the moon	Fine—the halo very large.
22	10		30.15	−0.17	0.415	68	53	15	4.491	4.616	7.316	..	..	....	....	..	..	1.04	SES	little	cirri and cumuli	Very fine.
	4		30.18	+0.03	0.458	77	56	21	4.876	5.068	9.688	77	..	....	....	..	..	1.82	....	ditto	none	Ditto ditto.
	10		30.16	....	0.415	59	53	6	4.559	4.616	5.570	..	51	46	....	..	..	0.37	....	ditto	none	Ditto ditto.
23	10		30.04	....	0.474	69	57	12	5.121	5.235	7.541	..	..	....	....	..	..	0.89	SE	gentle	none	Beautiful morning.
	4		29.97	....	0.474	72	57	15	5.090	5.235	8.270	72	..	....	....	..	..	1.53	E	brisk	none	Very fine.
	10		29.92	....	0.443	59	55	4	4.866	4.910	5.570	..	53	49	....	..	..	0.26	....	little	none	Ditto.
24	10		29.81	−0.37	0.490	69	58	11	5.293	5.402	7.541	..	..	....	....	..	..	0.83	S	ditto	small cumuli	Ditto.
	4		29.86	+0.05	0.429	70	54	16	4.632	4.770	7.776	72	..	....	....	.	..	1.50	SWS	brisk	ditto and cirrus	Fine.
	10		29.84	....	0.375	58	50	8	4.135	4.195	5.402	..	49	46	....	..	..	0.46	....	calm	overcast	Dark.
25	10		29.82	....	0.415	58	53	5	4.575	4.616	5.402	..	..	....	....	..	..	0.47	SW	high	cirrus, cumulus, and scud	Three strata of clouds.
	4		29.80	....	0.429	57	54	3	4.745	4.770	5.235	62	..	....	....	..	..	0.29	W	ditto	ditto ditto ditto	Hard showers.
	10		29.80	−0.06	0.351	50	48	2	3.925	3.940	4.195	..	44	31	....	..	..	0.10	....	little	none	Moon rather dull.
26	10		29.88	+0.06	0.339	60	47	13	3.721	3.815	5.761	..	..	....	....	..	..	0.74	SWS	ditto	cumuli	Overcast.
	4		29.83	....	0.401	59	52	7	4.405	4.468	5.570	62	..	....	....	..	..	0.43	....	ditto	ditto and cumulo-strati	Showers.
	10		29.79	....	0.443	56	55	1	4.901	4.910	5.068	..	52	51	....	..	..	0.07	....	brisk	overcast	Heavy—showers.
27	10		29.71	....	0.401	55	52	3	4.414	4.468	4.910	..	..	....	....	..	..	0.17	W	little	stratus and cumulo-stratus	Hard showers.
	4		29.56	−0.30	0.443	59	55	4	4.866	4.910	5.579	59	..	....	....	..	..	0.26	NW	ditto	ditto ditto	Ditto ditto.
	10	○	29.68	+0.12	0.339	52	47	5	3.777	3.815	4.468	..	49	44	....	..	..	0.24	....	ditto	ditto ditto	Ditto ditto.
28	10		29.65	....	0.351	59	48	11	3.856	3.940	5.570	..	..	....	....	..	..	0.81	SW	brisk	cumuli and stratus	Heavy and threatening.
	4		29.62	....	0.388	56	51	5	4.291	4.330	5.068	60	..	....	....	..	..	0.36	....	ditto	ditto and scud	Hard rain.
	10		29.50	....	0.388	32	51	1	4.323	4.330	4.468	..	47	43	....	..	..	0.05	....	little	overcast	Rain—very dark.
29	10		29.41	....	0.294	57	43	14	3.240	3.396	5.325	..	..	....	....	.	..	0.92	W	brisk	cumuli	Very threatening.
	4		29.41	....	0.375	53	50	3	4.172	4.195	4.616	59	..	....	....	..	..	0.16	....	little	ditto and nimbi	Heavy showers—hail and thunder.
	10		29.40	....	0.283	46	42	4	3.190	3.214	3.699	..	42	37	....	..	..	0.18	....	ditto	few	Fine.
30	10		29.40	−0.28	0.283	55	42	13	3.135	3.214	4.910	..	..	....	....	..	..	1.00	W	high	cumuli and cirri	Overcast.
	4		29.41	....	0.294	58	43	15	3.234	3.326	5.402	60	..	....	....	..	..	1.23	....	ditto	ditto ditto and nimbi	Light showers.
	10		29.42	....	0.294	51	43	8	3.275	3.326	4.330	..	45	40	....	..	..	0.48	....	brisk	overcast	Dull.
31	10		29.45	....	0.283	56	42	14	3.130	3.214	5.068	..	..	....	....	..	..	1.10	....	high	nimbi and scud	Hard showers—hail.
	4		29.46	....	0.351	60	48	12	3.853	3.940	5.761	59	..	....	....	..	..	1.10	....	ditto	ditto ditto and cirri	Showers.
	11		29.51	+0.11	0.283	45	42	3	3.196	3.214	3.570	..	42	37	....	..	..	0.13	....	little	none	Very fine and clear.

The means of the three months, March, April, and May, forming the third quarter of a year, during which I have continued these experiments, are as follow:—

Pressure of the atmosphere	29.88
Ditto of the vapour	0.300
Weight of vapour in a cubic foot	3.346
Degree of dryness	8
Evaporation per minute from a surface six inches diameter	0.48
Temperature	48½°

By subdividing, as before, into half-quarters, we obtain, for the first period, *viz.*, all March and half April,

Pressure of the atmosphere	29.80
Ditto of the vapour	0.268
Weight of vapour in a cubic foot	3.013
Degree of dryness	5½
Evaporation per minute from a surface six inches diameter	0.27
Temperature	43°

For the second period, *viz.*, half April and all May,

Pressure of the atmosphere	29.95
Ditto of the vapour	0.333
Weight of vapour in a cubic foot	3.680
Degree of dryness	10½
Evaporation per minute from a surface six inches diameter	0.70
Temperature	54°

Art. VI.—*A Biographical Memoir of* Arthur Young, Esq., F.R.S., *&c., Secretary to the Board of Agriculture (from Original Documents, furnished by his own Memoranda). By* J. A. Paris, M.D., F.L.S., M.R.I., *Fellow of the Royal College of Physicians, Honorary Member of the Board of Agriculture, &c.*

In recording the life of an individual eminent for his writings or discoveries, in philosophy or literature, the biographer is not unfrequently charged, by a considerable portion of his readers, with having lavished praise, where it was not justly merited, or attached an importance to labours, ill according with their intrinsic worth, and acknowledged utility. This depends, in a great degree, upon that natural and inherent diversity of constitution of the human mind, which leads different individuals to appreciate the value of intellectual exertions by very different standards. We are, besides, too much disposed to underrate attainments which we do not ourselves possess, or, in the value of whose applications we are not likely to participate; indeed, in some instances, this feeling is carried to so mischievous an extent, that we are induced to regard the zeal and enthusiasm, evinced for particular pursuits, as traits of weakness in the individuals in which they occur; and thus the mental, like the corporeal eye, by a species of natural illusion, perceives the cloud which exists within itself, as a dark spot in the illuminated object which it contemplates,—but I am illustrating an embarrassment, which, as the biographer of Arthur Young, I may reasonably hope to escape, for agriculture, above all others, is a branch of human knowledge, whose application comes home to the business and bosom of every individual, however humble or exalted may be his station,—limited, or extended his wants,—and diversified his pleasures, or occupations; while the successful progress and improvement of this art form a subject of such general and common interest, that I apprehend no individual will withhold his tribute of grateful respect to the memory of an aged and patriotic citizen, who concentrated,

during a long life, all the energies of a most vigorous intellect upon this one grand object, and whose writings will amply justify me in asserting, that no individual ever existed, in any age, or country, who so widely extended the boundaries, and so profitably multiplied the resources of rural economy. "To the labours of Mr. Arthur Young," says Kirwan*, "the world is more indebted, for the diffusion of agricultural knowledge, than to any writer that has yet appeared."

ARTHUR YOUNG was the descendant of a respectable family, who had resided on their estate at Bradfield Combust, near Bury St. Edmonds, in the county of Suffolk, for more than two centuries; he was born in the house of Mrs. Kennon, the celebrated midwife to Queen Caroline, in Clifford-street, London, on the 7th of September, 1741. His father, the Reverend Arthur Young, Doctor in Divinity, was a Prebendary of Canterbury, Rector of Bradfield Combust, Bradfield Saint Clair, and of Exning, near Newmarket, and Chaplain to Arthur Onslow, Speaker of the house of Commons: he was an extremely active magistrate, and an intelligent scholar, and is known in the annals of theological literature as the author of a work, entitled, "*An Historical Dissertation on Idolatrous Corruptions in Religion*†;" it was published in 1734; the first volume of the work was dedicated to Arthur Onslow, the Speaker; the second, to the Bishop of Bristol, both of whom stood godfather to his son, Arthur. Dr. Young married Anna Lucretia, daughter of John Crousmaker, Esq., in 1725, by whom he had three children,—John, Doctor in Divinity, Prebendary of Worcester, and Fellow of Eton, who broke his neck, when hunting with his late Majesty, in 1786; the second child was a daughter, Elizabeth Mary, who died soon after her marriage with John Tomlinson, Esq., of East Barnet, in Hertfordshire; the third was Arthur, the celebrated subject of the present memoir.

---

* Irish Transactions, Vol. v.

† This work is quoted by Voltaire; and, amongst the documents of Mr. Young, is a complimentary letter, addressed to his father, upon the subject of this publication, from Sir Benjamin Keene, British Ambassador at Madrid.

Arthur Young received a grammatical education at Lavenham, a school about six miles distant from Bradfield Hall, whither he was sent in 1748, and, had not maternal fondness interposed her edicts, he would subsequently have gone to Eton, and from thence to the University to receive an academical education like that bestowed upon his elder brother. He gave, it is said, very early prognostics of his future eminence, and was much esteemed by his early friends and preceptors, as a boy of very superior talents, and indefatigable industry; he left school in 1758, and was placed, by the anxious desire of his mother, in the house of Messrs. Robertson, merchants at Lynn, in Norfolk, in order that he might be qualified for entering into business with his brother-in-law, Mr. Tomlinson, of London; his sister however died in the interval, and his father's intention was in consequence relinquished. It has ever been a matter of serious regret, with Mr. Arthur Young, through life, that the premium paid by his father to the Lynn merchant, had not been applied in supporting him at college, when, by taking orders, he might have held the rectory of Bradfield, a piece of preferment which was afterwards bestowed upon his olde preceptor of Langham school: posterity will hardly sympathize with him at this circumstance; his mind was cast in a very peculiar and original mould, and it is a question, whether the refinements of literature might not have changed its texture and composition, and repressed that vigour, and boldness of thought, and strength of expression, which so prominently characterize his writings, and which break the even surface of his ordinary details, with an inequality of feeling, that is ever opposed to that insipidity, which we so frequently experience in the writings of more polished scholars.

During his residence at Lynn, his time seems to have been divided between dancing and reading; he was a young man possessed of more than an ordinary share of personal attractions, and he became so great a favourite with those who knew him, that he was a welcome guest at every entertainment: but the allurements of dissipation never interfered with the more solid pleasures which he derived from study; he read with an

unabated avidity every work which he could procure, and as his allowance for pocket-money was but scanty, he determined to augment his resources by the emoluments of authorship, and accordingly, at the age of seventeen, he commenced his literary career by writing a political pamphlet, entitled, "*The Theatre of the present War in North America*," for which his London bookseller allowed him a number of books, to the amount of ten pounds: encouraged by this compensation, he sent him several other manuscripts, among which were four novels*, and he received for each a further supply of books. His father died in 1759; and in the year 1761 he was attacked with a hemorrhage from the lungs, in consequence of which he was ordered by his medical advisers to the hot wells at Bristol; here his skill in the game of chess brought him in contact with Sir Charles Howard, K. B., with whom he formed an intimate acquaintance, and was offered by him a pair of colours in his own regiment of cavalry, but, fortunately, his mother, his constant guardian angel upon these occasions, would not hear of his going into the army, and the favourite scheme was therefore abandoned. In January, 1762, he started a periodical publication, under the comprehensive title of "*The Universal Museum*," but upon his soliciting Dr. Johnson to contribute his powerful assistance in its support, he received from the Doctor so strong a persuasion to abandon his intention, that, after the publication of six numbers, he disposed of it to the booksellers. In 1763 he returned from the residence of his uncle in London to his mother at Bradfield Hall, without any prospect of a pursuit, profession, or employment: his whole income, during the life of his mother, arising from a copyhold farm of twenty acres, and producing only as many pounds. She was anxious that he should reside with her, and, as the lease of her farm of eighty acres would shortly expire, she urged him in the most affectionate manner, to undertake its cultivation, a scheme so much in unison with his taste and wishes, that he did not long hesitate in accepting her propo-

* *The Fair American*; *Sir Charles Beaufort*; *Lucy Watson*; and *Julia Benson, or, the Innocent Sufferer.*

sal,—and he embarked as a farmer. Young, eager, and totally ignorant as he then was of every necessary detail, it is not surprising, as he has since said, that he should have squandered large sums, under golden dreams of improvements, especially as he connected a thirst for experiment without a knowledge of what it demanded for its success, or what were the fallacies to which it was exposed in the execution. In the following year he commenced a correspondence in the periodical work, entitled *Museum Rusticum**; this was his earliest effort in agriculture, and in 1765, by the strong persuasion of the well-known Walter Hart, the tutor of Mr. Stanhope, the son of the celebrated Lord Chesterfield, he collected these letters, and reprinted them, under the head of "*Sylvæ*," as an appendix to his new publication of the *Farmer's Letters*, a work in which he treats of several subjects, connected with the farming interests, with much ability and success, as, on the advantages of a general and extensive exportation of corn, and on the balance of agriculture and manufactures, maintaining that the former ought to flourish, to the full cultivation of the land, before the latter should take place as articles of commerce. In this year (1765) he married Miss Martha Allen, of Lynn, a lady of a very respectable family, whose sister was the second wife of the celebrated Dr. Burney of Chelsea; she was the great-grand-daughter of John Allen, Esq., of Lyng House, in the county of Norfolk, who, according to the Count de Boullainvilliers, was the first person who used marl as a manure, in that county. Mrs. Young possessed all the attractions of person, the accomplishments of mind, and the excellence of heart, to have rendered her a suitable companion for Arthur Young, but it proved to be the very reverse of a happy union; it would ill become one who has enjoyed the pleasures of her society, and the advantages of her friendship, to offer any comment upon the family circumstances that might have occasioned so unfortunate an event; nor is it the business of a

* It is a singular circumstance, that this work contains also the first essay written by Mr. Edgeworth, when he was only 19 years of age, on the subject of "*Wheel Carriages.*"

biographer, while he canvasses the public claims of a distinguished individual to the gratitude of posterity, to violate that sacred principle of decorum, by which an impenetrable veil is so properly thrown over the private occurrences of domestic history. Immediately after their marriage, they boarded with his mother at Bradfield; a mixture of families is never calculated to ensure harmony, and a declining purse, and the prudent caution of an affectionate mother, induced him in the year 1767 to undertake the management of the farm of Samford Hall, in Essex, which consisted of about 300 acres of land; but Fortune is not, as the Roman satirist would make us believe, a deity of our own creation; various unforeseen circumstances, and unavoidable embarrassments from the want of capital, induced him to give a hundred pounds to a farmer for taking the estate off his hands; and it is not a little singular, that this same farmer, by the advantages of capital, very shortly realized a fortune upon it. It was here, uniting the plough and the pen, that he wrote his work, entitled, "*Political Essays on the present State of the British Empire*," but which was not published until 1772, in one volume quarto. After having thus disposed of Samford Hall, he advertised for another farm, and the knowledge which resulted from viewing the different estates that were on this occasion presented to his notice, furnished him with the materials for his tour, which he called, "*The Six Weeks' Tour through the Southern Counties.*" By the advice of his Suffolk bailiff, he hired a farm of one hundred acres in Hertfordshire; and, from viewing it in an uncommonly favourable season, they were both deceived in the nature of the soil. "I know not," says Mr. Young, to use his own energetic language, "what epithet to give this soil; sterility falls short of the idea,—a hungry, vitriolic gravel,—I occupied for nine years the jaws of a wolf. A nabob's fortune would sink in the attempt to raise good arable crops, upon any extent, in such a country; my experience and knowledge had increased from travelling, and from practice, but all was lost when exerted upon such a spot. I hardly wonder at a losing account, after fate had fixed me upon land, calcu-

lated to swallow, without return, all that folly or imprudence could bestow upon it." It will be here naturally asked, why he did not go to land decisively good? He answers the question very satisfactorily. "It was on account of the houses; for although I saw numerous farms that would have suited well, they had wretched hovels on them."

His "*Six Weeks' Tour*," excited a great sensation in the agricultural community, and numerous and pressing were the applications which he received, both personally and by letter, to undertake journeys through other districts, and to record the result of them upon a similar plan; he was accordingly induced, in the year 1768, to perform a tour through the north of England, during which he collected so much information, that the publication occupied four volumes, octavo, and so eagerly was it purchased, that the first edition was very shortly out of print. In the succeeding year, he gave to the Public his ideas upon "*the Expediency of a free Exportation of Corn*," a work at which his late Majesty expressed the strongest marks of approbation, as the Archbishop of Canterbury informed his brother, Dr. John Young. In 1770, he proceeded on his eastern tour, during which he formed an intimate acquaintance with John Arbuthnot, Esq., the father of the present Secretary to the Treasury; a circumstance which he always mentioned with pleasure, and his memoranda abound with the strongest expressions of regard and friendship for him. This tour was also published in four volumes octavo. As this was the last of his English tours, and, unquestionably, the best, I shall beg leave to pause in my narrative, to offer a few remarks upon the character and importance of their composition, and the almost magical influence which they produced upon the agriculture of England; and if it be true, that he who can point out and recommend an innocent pleasure is to be esteemed an equal benefactor to mankind with him who makes a useful discovery, I claim for Mr. Young, from the hand of the moralist, an additional laurel to decorate his well-earned wreath of popularity. A taste for agricultural pursuits now became general; and it has been said, and perhaps not without justice, that the writings of

Arthur Young produced more individual harm, and greater public good, than those of any person who had ever written—but the former inconvenience must always attend the introduction of any new system, of general application, that requires prudence and skill for its successful direction. It is difficult to say upon what points his English tours best deserve our commendation; whether for the store of practical agriculture which they present, or for the vast and important information they afford on subjects of political economy. But in forming a just estimate of their intrinsic worth, and in understanding the full nature and extent of the public obligation to their author, it must be remembered, that their objects were no less novel than their execution was unexampled. No work, in any way approaching them in resemblance, had appeared in any country; true it is, that numerous journeys had been performed through Great Britain, and various tours had been written, but they were all deficient in the grand and striking excellence, which gives such pre-eminence to those of Mr. Young. All former tourists confined their descriptions to towns and seats, as if they had actually floated in the air, without paying any regard to the aspect of the country through which they passed to arrive at them, or the state of agriculture, as it existed between the isolated objects of their admiration; and as they had no inducement to quit the high roads, and deviate from the beaten line of country, their descriptions were necessarily characterized by tedious repetition and monotonous dullness. A detailed relation of the practical husbandry which he witnessed, and of the experimental observations of the numerous gentlemen whom he visited, during a tour of 4,000 miles, through a country so limited in extent as that of England, could not fail to bring together a mass of knowledge of the most interesting description; and the able and candid manner in which the defects of each practice and system are portrayed, laid the first solid foundation for the permanent improvement of the soil, while the comparative view which he offers of the effects of the different modes of cultivation, as practised in different districts, conveys instruction to the farmer, without the trouble of ex-

periment, and a knowledge of profit and loss, without the labour or errors of calculation. His writings have thus diffused through the empire the practices that have been found advantageous in particular places; and local knowledge has become general science; thus, for instance, until the publication of his Eastern Tour, how extremely circumscribed were the knowledge and practices of Norfolk husbandry! In the same tour he explains the Suffolk cultivation of carrots, and points out the value of that root for sustaining the best breed of farm horses in the kingdom—he describes, likewise, the cultivation of cabbages, as practised in Yorkshire—the culture, advantages, and immense profits of crops of *Lucerne*—he places also in a very striking and satisfactory point of view, the unnecessary waste of strength employed in the tillage of the kingdom—he presents to the farming world a notice of the best implements, and, to all this, he adds much practical information on the important subject of a *correct course of crops*, on which all preceding writers had been silent. I remember, in a conversation with Mr. Young, his stating to me his impression of this being by far the most useful feature of his tours; and he thought that no circumstance, in all his writings, had produced so beneficial a tendency, as that which had turned the attention of farmers to this very important, but neglected, point. In fine, these popular works may with much truth and justice be said to have formed a new epoch in the agricultural history of Europe, and to have afforded the grand basis of all the improvements that have been made during the last fifty years; before this period, there was not a publication upon the subject of British agriculture, from which we could glean any useful information. If it were necessary to substantiate this assertion, I should remind the reader of a late Lord Chancellor of England, who read every English work that he could procure upon the subject of husbandry; but finding, instead of instruction, nothing but folly and contradiction, he committed them all to the flames. In the execution of these writings, their spirited author has occasionally relieved the monotony of agricultural subjects with animated descriptions of those objects of elegance and art

that adorned the several provinces through which he passed, so that, while the internal economy of the earth formed the basis of his works, its external ornaments may be said to have furnished the materials for their embellishment. In the opinion of some cotemporary critics, this was considered as an objectionable part of the composition—it was denounced as a light, flimsy style, unworthy of the grave and important features with which it ought to harmonize. I protest against the sentence of so churlish a tribunal. Surely the philosopher who raises a solid temple to the genius of cultivation, may entwine its pillars with flowers, without interfering with the utility of the structure, or the simplicity of its design. But what can afford a higher testimony of the intrinsic worth of these works, than the avidity with which they have been received? Foreign nations, in common with England, have felt their political importance, for they have appeared in almost every language of Europe; and, by the express command of the Empress Catherine of Russia, they were translated into the language of that country, for the purpose of diffusing a knowledge of practical agriculture, and of encouraging a spirit of enlightened industry over the almost boundless territories of her mighty empire. His "*Rural Economy*," appeared in 1770, and in the same year was published, in two volumes, quarto, his "*Course of Experimental Agriculture*," dedicated to the Marquis of Rockingham, "*containing an exact register of all the business transacted during five years, on nearly* 300 *acres of various soils; the whole demonstrated in* 2,000 *original experiments*." In this work there is certainly much to praise, but, at the same time, much to reprehend: Mr. Young was truly sensible of its faults, and constantly expressed his regret at having so hastily published it, and, in his latter years, he made a point of destroying every copy that he could get into his possession. The merits of the work may be said to consist in his efforts to ascertain the real and comparative utility of the broadcast and drill husbandry; in the demonstrations which he produces to prove, that a much greater quantity of seed than that which modern writers usually prescribe, is in *most* instances necessary;—in his advice re-

specting a junction of *tillage* and *manure*, shewing that the former will never be successful without the latter, and that raising large quantities of manure should be a principal object with the farmer: there is also some important matter with regard to the time of sowing, and on the introduction of *fallow crops*, instead of *wasteful fallows*, and on the hoeing both of beans and turnips. In the year succeeding, he published that well-known work, the "*Farmer's Calendar*," which has passed through ten editions; at the same time he wrote "*Proposals to the Legislature for numbering the People*;" a third edition of his "*Farmer's Letters*," also appeared, with an additional volume, in which he shews the advantages which would accrue to the great landed proprietors, by improving their estates, and he observes, that in this manner they might so extend their incomes, as to render it unnecessary for them to make any application to the ministry for a *place*, or to the city for a *wife*. In 1773, he was elected Chairman of the Committee of Agriculture, in the Society of Arts, and he first proposed their publishing an annual volume of Transactions, a plan which was adopted in 1783; in this year he also published a third edition of the "*Southern Tour*," "*Political Essays on the present State of the British Empire*," and "*Observations on the present State of the Waste Lands*." In this latter essay, he suggested a a plan, as simple as it was original, that would enable a very moderate capital to improve very extensive tracts of waste. Without entering into any details, it may be observed, that the leading principle developed in this treatise, was to form, every year, after the first four or five, a farm of just that size which would let the most readily in the neighbourhood, and when such farm had been finished and let, to sell it, and apply the product of such sale to the progress of the improvement.

Finding at this time that his income was barely sufficient to meet his expenditure, he engaged to report the Parliamentary Debates for the Morning Post, this he continued to perform for several years; and after the labours of the week, he walked every Saturday evening to his farm, a distance of seventeen miles from London, from which he as regularly returned every

Monday morning. This was the most anxious and laborious part of his life: "I worked," says he, "more like a coal-heaver, though without his reward, than a man acting only from a predominant impulse." In 1774 he published "*Political Arithmetic*," a work which met with high consideration abroad, and was immediately translated into several languages. Mr. Young has left a memorandum which states, that he received for his different writings, in the interval between the years 1766 and 1775, the sum of three thousand pounds.

The years 1776 and 1777, were occupied by his tour through Ireland, which he commenced under the auspices of the most distinguished noblemen and gentlemen of that country, to whom he carried letters from Lord Shelburne, Mr. Burke, and other persons of distinction in England: on landing at Dublin, he was very politely received by Colonel Burton, who was afterwards Lord Conyngham, the aide-de-camp to Lord Harcourt, then lord-lieutenant, who conducted him to his Excellency's villa at Saint Woolstan, and made every arrangement for his tour that might in any way contribute to his comfort or instruction.

This celebrated tour was published in 1780, in one volume, quarto; Miss Edgeworth, in her "*Castle Rack Rent*," remarks, that it was the first faithful portrait of its inhabitants; but its claims to patronage were founded upon more solid grounds, its pretensions were of a higher order, and of a very different character from those of an animated and descriptive writer; it presented a vast store of agricultural and political knowledge relative to the cultivation and native resources of that kingdom, which has been the means of ameliorating the condition, and of promoting the happiness of the people. Were I to attempt any thing like an adequate analysis of this powerful work, time and space would alike fail me; I must therefore rest satisfied with noticing some of its more prominent features. That part of the publication which produced the greatest sensation upon the government, and effected the most important change in its measures, was his attack upon the bounty paid on the land carriage of corn to Dublin, in which he proved the

gross absurdity of the measure; and shewed, that the wretched tillage was at the expense of the richest pasturage in the King's dominions; and with such strength and perspicuity was this position supported, that it carried with it immediate conviction; and, in the very first session of parliament, after the publication of this work, the bounty was reduced to one half, and, finally, wholly abolished, by which a saving accrued to the Irish nation of eighty thousand pounds a year! What will posterity say of this country, when they learn that all Mr. Young received for this great and disinterested effort of political acuteness and judgment was a cold letter of thanks from the Dublin Society. "The future biographer," says Mr. Wakefield, "may be inclined to remark, that his country behaved to him as Frederic boasted he had done to Voltaire, *he had treated him like a lemon, squeezed out the juice, and then flung away the rind*, (Statistical Account of Ireland*, Vol. I.) Mr. Young also proved, in his masterly observations on the penal code of laws against the Roman Catholics, that they were not laws against the *religion*, but against the *industry* of the country; and his arguments have been frequently quoted both by writers and public speakers, as authority for the repeal of those obnoxious statutes, and his advice, to a considerable extent, has been followed. Amongst the manuscripts which he has left, numerous are the letters in commendation of this work, which were written to him by the most eminent men in Europe. Lord Chancellor Loughborough told him, that he had been much struck and delighted with his masterly arguments upon the subject of the corn bounty, adding, "Ireland ought to have rewarded you for so important a service." In the year 1777, he was presented with a medal by the Salford Agri-

* I have peculiar satisfaction in adducing the testimony of this enlightened writer, because his agricultural and political knowledge enabled him to appreciate the merits of Mr. Young. "Truth," says he, "compels me to declare, although the assertion may reproach my country, that *he has been ill requited* for his exertions in her service, and, that during the best days of his life, she seems to have been coldly insensible to the value of his indefatigable and important labours."

cultural Society, inscribed, "*For his Services to the Public.*" After the publication of his Irish Tour, in consequence of a very liberal offer from Lord Kingsborough, he returned to Ireland, in order to inspect and superintend his lordship's estate, and he resided for two years in a house built for his reception at Milchel's Town, in the county of Cork; owing to circumstances which it would be tiresome to detail, he did not remain much longer than twelve months, and, in the year 1779, we find him again quietly settled at Bradfield, having in vain endeavoured to gain his mother's approbation of a plan which he projected, of emigrating to America; from this period, he gradually extended his scale of husbandry, and with such animation did he enter into the details of his occupation, as to perform the manual operation of ploughing himself. Physiologists have asserted, that the energies of the mind are incompatible with the laborious exercise of the body, and that they are operations whose activity bears an inverse ratio with each other. Mr. Young may at least be adduced, as affording an exception to this law; for, at the same time that he was thus exerting his physical strength in the occupations of his farm, we find that his mind was engaged in a laborious chemical examination of various soils, and in recording and comparing the results of numerous agricultural experiments on the culture of potatoes, for which the Society of Arts adjudged him their honorary gold medal. This was a feature in the character of Mr. Young that always astonished the agriculturists of France. In the preface to a translation of his works, the author exclaims, "but this person who has written so much, and so well, is a *practical farmer!*" Mr. Young had become intimately acquainted with Dr. Priestley, at Lord Shelburne's, and had acquired from him a taste for pneumatic chemistry. To a man who had been accustomed to contemplate only the grosser forms of matter, and to consider the phænomena of soils, as alone depending upon their texture and density, it is not astonishing that his introduction by Dr. Priestley to a new aërial creation, should have excited his

wonder and astonishment, and have opened to his view a fresh train of active research: he had often expressed to his friends the surprise with which he witnessed the address of Priestley, in collecting, transferring, and examining airs; and, upon being asked one day in what experiments he had been engaged, his answer shews how strong an impression the command which had thus been acquired over invisible elements had produced upon him; and it affords, at the same time, no bad specimen of his terse and humorous style of expression:—" I have been engaged in examining airs, to be sure,—I have been *washing* fixed air, and *hanging it out to dry*." In 1782, we find him busily engaged with a curious controversy with Mr. Capel Lofft, upon the propriety of the county of Suffolk building and presenting the government with a 74 gun ship: the letters were printed in the "*Bury Post*," and were the means of establishing that newspaper in the public estimation. At about this period, Prince Potemkin, the Russian prime minister, sent three young Russians to be instructed by Mr. Young in the arts of husbandry; and, in the following year, the Empress Catharine presented him, through the hands of her Embassador, with a magnificent gold snuff-box, together with two rich ermine cloaks, designed as gifts to his wife and daughter.

In 1784, he commenced the publication of his "*Annals of Agriculture*," in which he appeared in the double capacity of editor and author, a work which he continued to the period of his blindness: it extends to forty-five volumes, *octavo*, and presents a vast store of information upon subjects of agriculture and political œconomy. The plan upon which it was conducted was one which ought to have ensured for it more extensive and profitable patronage, for, instead of recording anonymous correspondence, it refused admittance to any paper that had not the name and address of its author: it can accordingly boast of communications from the most exalted and enlightened characters in Europe, at the head of whom stands our late most gracious Sovereign, who transmitted to Mr. Young for publication, an account of the farm of Mr. Ducket the able

cultivator of Petersham*, which is recorded in the seventh volume of the annals, under the signature of *Ralph Robinson.* The King regularly read this work, as it came out, and he took occasion to thank Mr. Young for the pleasure which he received from its perusal, on the terrace of Windsor; upon which the Queen observed, that his Majesty never travelled without a volume of the Annals in his carriage. During the absence of Mr. Young on the continent, it appears that an offensive paper was inserted in the eleventh volume, "on the System of the Universe," by the Earl of Orford, upon reading which, the King exclaimed—"What! are the *Annals of Agriculture* becoming the vehicle of infidel opinions? If so, one of my strongest supports has failed me." The matter was afterwards explained, and his Majesty expressed himself perfectly satisfied. It deserves notice in this place, that, in 1803, the King of Naples became a subscriber, and, at the same time, sent a Neapolitan to be instructed by Mr. Young in agriculture. Amongst the more valuable communications in this work, we must not pass over unnoticed the *Letters on the present State of Agriculture in Italy*, by Dr. Symonds, Professor of Modern History in the University of Cambridge.

The papers written by Mr. Young are of the most interesting description, abounding with specimens of his original and beautiful style of writing; whenever he speaks of the pleasures of agricultural pursuits, his pen is inspired; if the strains of Petrarch were modulated by the softness of the breeze and the murmur of the fountains of Valclusa, with equal truth may it be said, that the rural writings of Arthur Young breathe all the freshness, and participate in the healthy vigour of that occupation, which forms the subject of his researches, and the theme of his panegyric. I cannot resist the temptation of presenting the reader with a quotation from his Essay on the Advantages of a Farmer's Life: after contrasting the other pursuits of pleasure, he exclaims, "far different from these is

* The King often visited the farm of this gentleman; a circumstance which contributed in no small degree to his zeal for agriculture: he used to say, that his Majesty's attention to his farm was *as dew upon the grass.*

the amusement of the farmer: the perpetual renovation of employment is to him a source of perennial pleasure. To see every object budding into life, at the genial summons of returning spring, while all the colours of reviving nature glow with a lustre excited by the efforts of his industry. The russet landscape stealing into verdure till every scene is pregnant with delight. Each field, alive with tillage, opening the grateful bosom of the earth to receive the seeds of those innumerable plants which vegetate for the wants, or blossom for the pleasures, of mankind. To hail the yellow shoots that scatter their pale verdure over the glebe, which each returning sun matures into mellower tints. To eye with rapture the brighter hues that paint the spots where art contends with nature; and the gradations of luxuriant growth that follow the variations that experiment has traced. With warmer suns to see the lawn alive with sheep, or spread with the picturesque labours of the hay-maker; the stately oxen varying their march with the heat of the day, now in the vale, then in the shade of some spreading beech, or catching every breeze on the elevation of a hill, while the tinkling of the distant fold closes the eve. To assist with incessant attention the progress of vegetation towards the maturity of harvest,—towards that season of joy, when crowded barns prove insufficient for the increase which art and industry command; when the orchard's loaded branches bid streams nectareous warm the peasant's heart.—When *sliding through the sky*,

> '*Pale suns unfelt at distance roll away,*'

and gild with their beams another hemisphere, not idle in their absence, the provident husbandman sees his flocks and herds securely sheltered, warmly imbedded, and treated luxuriously with verdant vegetation, even in the chilling blasts of frost and snow. The planter, appropriating the right soil for the beauties of the landscape, marks his barren spots, and the *prophetic eye of taste* sees refreshing shades thicken over the bleak hills: then also the properties of your soils demand attention; the elaboratory opens its recesses, and gives to wintry darkness

the illumination of science. The food of plants and progress of vegetation, and the secret powers by which the ambient air shakes from its breezy wings the wonders of fertility; the chain of hidden fire that connects the vegetation of a plant with the lightning that flashes in the heavens, are unfolded to him who is curious to fathom the depths of this noble science, that, with an endless variety, suffers no minute to pass heavily in its progress, but presents, to every cultivated mind, an incessant renovation of never-failing pleasures." Having examined agriculture as a pursuit of life, he proceeds to speak of its merit in harmonizing with the views of a family, " almost all other occupations that strongly attract the mind, exclude a woman from all participation, and are, for that reason, if for no other, perfectly good for nothing; but many of them do more than exclude, for they not only prevent her from associating in the amusements of her husband, but they abridge or prevent those that are properly her own: the question then that remains for an amiable woman to reflect on is, what pursuit will come nearest to her wishes?—And is it possible, ye Fair! that a doubt or hesitation can enter your minds? If your happiness depends on that of the man you have taken to your bosom, every argument which calls on him to make the choice, calls equally on you to second it: the empire of a virtuous mistress is the magic charm of love—a spell more powerful than all the fables of enchantment—enjoyment scatters the delusion. The silken chain by which the wife must continue her dominion, is spun from the finest threads of feeling that connect congenial bosoms. Gentleness and suavity, cheerfulness and good humour, will make time stand still on your brow, and prove in the eye of that friendship, into which passion can subside, a perpetual renovation of your charms."

In 1785 his mother died, for whom he entertained the most sincere affection, and he always mentioned her name with the warmest expressions of gratitude. Posterity too ought, in justice, to consecrate her memory. It has been somewhere said, that celebrated men have more frequently been indebted to the mother, than the father, for the formation of that peculiar

character, upon which their eminence depended. I do not mean to discuss this question, but the present instance certainly countenances such an opinion. Mr. Young owed much to his mother; her fondness and affection rescued him from that barren routine for which he was destined, and directed his mind to the pursuit of agriculture;—her anxious solicitude saved him from the vortex of military dissipation, into which he would otherwise have fallen; and her firm and steady advice prevented his emigrating into a foreign land; and thus she preserved for her country, one whose writings will shed a lustre on her name for future ages. In 1786 Mr. Young sustained a severe family blow, in the sudden and untimely death of his brother, Dr. John Young, who, having borrowed from Lord Hinchinbroke a spirited hunter, in consequence of his own being out of condition, broke his neck as he was hunting with his late Majesty near Windsor: this event deprived his son of his best friend and patron, and blasted all his future hopes and prospects, for he had been placed by him at Eton, and would have been amply provided for in the church, as soon as he was of age to hold the preferment. Early in the spring of 1787, he received from Mons. Lazouski at Paris, a gentleman who had formerly accompanied the two sons of the Duke de Liancourt to England, for the sake of Mr. Young's instructions, a pressing invitation to accompany the Count de la Rochefoucauld in a tour to the Pyrenees; this, says Mr. Young, was touching a string tremulous to vibrate: he had long wished for an opportunity of examining France—the effects of its government—the condition of the farmers and of the poor—the state and extent of the manufactures, with an hundred other inquiries, certainly of political importance; yet, strange as it may seem, not to be found in any French work, written from actual observation. Mr. Young therefore eagerly accepted the proposal, and having completed the tour, returned to England in the following winter; and here a new scene of bustle presented itself; the wool bill arose, and he was deputed by the wool-growers of Suffolk to support a petition against its passing into a law; a proof, says he, at least, that a prophet may

sometimes be esteemed in his own country; upon this occasion he united with Sir Joseph Banks, who was also deputed by the county of Lincoln, for the same object. As an account of this bill is to be found amply detailed in the Annals of Agriculture, I shall merely observe in this place, that its object was to prevent wool, of British growth, from being smuggled to France, this, at least, was the ostensible and avowed object, but Mr. Young always considered the real wish of the manufacturers was to reduce the price, by laying it under heavy restrictions. He was examined at the bars of the Lords and Commons, and published two pamphlets on the subject; he however only succeeded in moderating some of the more hostile clauses; the zeal which he displayed upon the occasion gave great offence to the manufacturers, and Sir Joseph Banks, in a letter to him, at about this period, gives him joy of his having been burnt in effigy at Norwich, on so laudable an occasion: on the other hand, he received from the pens of the most eminent political economists, tributes of praise for his manly and disinterested exertions, and a pamphlet was addressed to him upon the subject, by Thomas Day, Esq., a gentleman well known as the author of *Sandford and Merton*, and who has more recently been brought before the public eye, by the notice taken of him in the "*Memoirs of Richard Lovel Edgeworth, Esq.*" In this pamphlet he says, "If we are delivered from the present danger, I know no one who has so great a claim to the public gratitude as yourself; as soon as the storm began to gather, your active eye remarked the curling of the waters, and the blackening of the horizon, while every other Palinurus was quietly slumbering around: distinguished, therefore, as you long have been by literary talent, you have now added a nobler wreath, and a sublimer praise to all you merited before."

In the following July, he set out, alone, on his second journey to France, but he had not proceeded more than an hundred miles, before his mare fell blind; not however discouraged by this accident, he travelled with her 1,700 miles, and brought her safe back to Bradfield. Still finding that his survey of France

was incomplete, he determined to undertake a third expedition, and he accordingly again quitted Bradfield, on the 2d of June, 1789, in a one-horse chaise, as he had before found it extremely inconvenient to convey specimens of any remarkable soil, of manufactures, and wool, *&c.*, on horseback. During these three tours he passed through every province of France, resided some time at Paris, at the Duke of Liancourt's, in the midst of the revolution; he viewed the greater part of Lombardy, so interesting for its pasturage; and, in his first journey, he made an extensive excursion into Spain. In consequence of his health having sustained a severe shock, from a fever that attacked him, in the autumn of 1790, these travels were not published until the year 1792, when they appeared under the title of "*Travels during the years* 1787, 1788, *and* 1789, *undertaken more particularly with a view of ascertaining the Cultivation, Wealth, Resources, and National Prosperity of the Kingdom of France*;" in two volumes, *quarto*. During this interval he made an effort in practical agriculture, which deserves to be recorded on account of its importance; he was the first person who commenced the cultivation of artificial grasses, which he performed by collecting the seed by hand, and sowing it, although the merit of it has been unjustly claimed by others; he introduced more especially the *dactylus glomeratus*, or cock's foot, and the *cynosurus cristatus*, or crested dog's tail grass.

His French travels are superior in style and interest to his Irish tour: they consist of two distinct parts; the first volume contains his journal, the second, a series of essays upon the principal objects that he had observed. His diary is written in a familiar and easy style, and his descriptions are so agreeably circumstantial and unreserved, and constantly enlivened with such smart and unaffected *badinage*, that the reader becomes one of the party, and cheerfully attends him through his route with all the familiarity of an old acquaintance, participates in all his embarrassments, laughs with him at the follies he witnesses, and partakes of all the amusements, and the agreeable and instructive society, to which his celebrity introduced him. I regret that the space allotted for this

memoir will not allow the introduction of some copious extracts, in illustration of the terse and agreeable style of his diary. He thus describes a French inn: " They are better in two respects, and worse in all the rest, than those in England; eating and drinking are better beyond a question, and the beds will not admit of a comparison: after these two points all is blank. You have no parlour to eat in; only a room with two, three, or four beds. Apartments badly fitted up: the walls white-washed, or paper, of different sorts, in the same room; or tapestry, so old, as to be a fit nidus for moths and spiders; and the furniture such that an English innkeeper would light his fire with it: for a table, you have every where a board laid on cross-bars, which are so conveniently contrived, as to leave room for your legs only at one end; oak chairs with rush bottoms, and the back universally a direct perpendicular that defies all idea of rest after fatigue; doors give music as well as entrance; the wind whistles through their chinks, and hinges grate discord; windows admit rain as well as light, when shut they are not easy to open, and when open not easy to shut." The custom of dining at noon, so common in France, he found to be subversive of all pursuits, except the most frivolous; " we dress for dinner in England with propriety, as the rest of the day is dedicated to ease, to converse, and relaxation; but by doing it at noon, too much time is lost. What is a man good for after his silk breeches and stockings are on, his hat under his arm, and his head *bein poudré?*—Can he botanize in a watered meadow?—Can he clamber the rocks to mineralize?—Can he farm with the peasant and the ploughman?—He is in order for the conversation of the ladies, which to be sure is in every country, but particularly in France, where the women are highly cultivated, an excellent employment; but it is an employment that never relishes better than after a day spent in active toil, or animated pursuit; in something that has enlarged the sphere of our conceptions, or added to the stores of our knowledge." At Florence he visits the celebrated statue of Venus. " After all I had read and heard," says he, " of the Venus of Medicis, and the numberless casts

I had seen of it, which have often made me wonder at descriptions of the original, I was eager to hurry to the *tribua*, for a view of the dangerous goddess. It is not easy to speak of such divine beauty with any sobriety of language; nor without hyperbole to express one's admiration, when felt with any degree of enthusiasm; and who but must feel admiration at the talents of the artist, that thus almost animated marble? If we suppose an original, beautiful as this statue, and doubly animated, not with life only, but with a passion for some favoured lover, the marble of Cleomenes is not more inferior to such life in the eyes of such a lover, than all the casts that I have seen of this celebrated statue are to the inimitable original. You may view it till the unsteady eye doubts the truth of its own sensation: the cold marble seems to acquire the warmth of nature, and promises to yield to the impression of one's hand. Nothing in painting so miraculous as this. A sure proof of the rare merit of this wonderful production is, its exceeding, in truth of representation, every idea which is previously formed; the reality of the chisel goes beyond the expectancy of the imagination; the visions of the fancy may play in fields of creation, may people them with nymphs of more than human beauty; but to imagine life thus to be fashioned from stone; that the imitation shall exceed, in perfection, all that *common* nature has to offer, is beyond the compass of what ordinary minds have a power of conceiving. In the same apartment there are other statues, but, in the presence of Venus, who is it that can regard them? They are, however, some of the finest in the world, and must be reserved for another day. Among the pictures, which indeed form a noble collection, my eyes were rivetted on the portrait of Julius 2d., by Raphael, which, if I possessed, I would not give for the St. John, the favourite idea he repeated so often. The colours have in this piece given more life to canvass, than northern eyes have been accustomed to acknowledge. But the Titian!—enough of Venus;—at the same moment to animate marble, and breathe on canvass, is too much. By husbanding the luxury of the sight, let us keep the eye from being

satiated with such a parade of charms: retire to repose on the insipidity of common objects, and return another day, to gaze with fresh admiration." The French nation appear to have been duly sensible of the advantages which these travels were calculated to produce upon their agriculture: in a Preface to the translation of his works into the French language, in the year 1801, we meet with the following passage: "There is no person who does not recollect the general and agreeable impression produced in France, by the travels of Arthur Young, through the various provinces of that vast and rich country, which unites in itself all that a numerous population and the arts can add to the advantages of a climate the most happy. National rivalry gave place to admiration at the works of this new Triptolemus, who passed through Europe, for expanding new lights upon an art the most useful to mankind. Geographers and naturalists had already given us a knowledge of the general extent of France, and the disposition of its *bassins*, which form its principal rivers, but the geoponic division of its territory had never been traced in a manner so exact as it has been done by Arthur Young; that indefatigable and penetrating agriculturist has scrutinized it, even to the smallest *band* of its soil, for determining its nature, and appreciating its value. We see, with sparkling eyes, all the riches which Nature has lavished with prodigality, although it is to an Englishman that we are indebted for a knowledge of them."

At this period he commenced a correspondence with General Washington, which was afterwards published in a pamphlet, entitled, "*Letters from his Excellency General Washington, to Arthur Young, Esq., containing an Account of his Husbandry, his Opinions on various Questions in Agriculture, and many Particulars of the Rural Œconomy of the United States.*" This period was also marked by another event upon which Mr. Young always dwelt with pleasure,—the present of a Spanish Merino ram from the King. "How many millions of men are there," exclaims he, "that would smile, if I were to mention the Sovereign of a great empire giving a ram to a farmer, as an event that merited the attention of mankind: the

world is full of those who consider military glory as the proper object of the ambition of monarchs, who measure regal merit by the millions that are slaughtered, by the public robbery and plunder that are dignified by the titles of victory and conquest, and who look down on every exertion of peace and tranquillity, as unbecoming those who aim at the epithet *great*, and unworthy of men who are born the masters of the globe. But I believe the period is advancing with accelerated pace, that shall exhibit characters in a light totally new; that shall rather brand than exalt the virtues hitherto admired—that shall pay more homage to the memory of a prince that gave a ram to a farmer, than for wielding the sceptre obeyed alike on the Ganges and the Thames." In the early part of the year 1793, he became alarmed at the state of the public mind in this country, and published his celebrated pamphlet, entitled, "*The Example of France, a Warning to Britain.*" This was one of the most opportune and successful essays that ever appeared; it was a season of turbulence and terror, and the manly and honest warmth with which he vindicated our national principles, and deprecated those of revolutionary France, which he exposed in all the fulness of their deformity, and in the terrors of their operation, offered an appeal to our best feelings and passions, that was irresistible. The effect was electric; and votes of thanks poured in upon him from every patriotic association in the kingdom. It was to be expected, that a writer of such caliber would incur the bitter reproaches of those political partizans who maintained opposite opinions. Mr. Young accordingly has been accused of changing his political principles, and the charge has been supported by the production of passages from his *Travels in France*, which shew him to have been a friend to the Revolution. But hear his own defence:—"The Revolution, *before* the 10th of August, was as different from the Revolution after that day, as light from darkness; as clearly distinct in principle and practice, as liberty and slavery. For the same man, therefore, to approve of both, he must either be uncandid, or changeable; uncandid, in his approbation before that period,—changeable, in his approbation after it.

How little reason, therefore, for reproaching me with sentiments contrary to those I published before the 10th of August! I am *not* changeable, but steady and consistent; the same principles which directed me to approve the Revolution in its commencement, the principles of real liberty, led me to detest it after the 10th of August. The reproach of changeableness, or *something worse*, belongs entirely to those who did *not* then change their opinion, but approved the *Republic*, as they had approved the *limited Monarchy*". It deserves to be here recorded, that in this political pamphlet Mr. Young first recommended a *Horse Militia*, a force which was afterwards called the *Yeomanry Cavalry*. He was frequently complimented as the original projector of so valuable a plan, and his health was the first toast drank at their public dinners. He entered himself, as a private, into a corps established in the vicinity of Bury St. Edmonds, of which the present Marquis Cornwallis, at that time Lord Broome, was the Colonel. Shortly after this period, animated as he always was by the spirit of adventure, he could not resist an opportunity that occurred, for realizing the favourite speculation he had so long entertained—that of cultivating a large tract of waste land. He accordingly completed the purchase of 4,400 acres of waste, in Yorkshire. But his fates had decreed other things for him: a new scene, of a very different description, opened. The Board of Agriculture was established in the August of 1793, and he was immediately appointed its Secretary. It has been asserted, with much confidence, that this situation was given to him by the Government, as a reward for his political pamphlet,—but this is not true. An individual, it must be granted, is rarely appointed to an official situation on account of his possessing, in an eminent degree, those qualifications which its duties require; but in the instance of Mr. Young, this was undoubtedly the fact; his general and profound knowledge in agriculture was the only circumstance that marked him as the most proper person to fill a situation in every respect so important and honourable. "The gratification," says he, "of being elected into so respectable a situation, in which opportunities of still giving

an humble aid to the good cause of the plough, could scarcely fail of offering, would not permit me to decline the appointment; although, to a person established in the country, the salary*, with the residence annexed, was not that pecuniary object which my *Jacobin friends* have represented, and I must have improved on bad principles indeed, if it would not, in a few years, have turned out a more profitable speculation. What a change in the destination of a man's life! Instead of entering the solitary lord of 4,000 acres, in the keen atmosphere of lofty rocks and mountain torrents, with a little creation rising gradually around me, making the desert smile with cultivation, and grouse give way to industrious population, active and energetic, though remote and tranquil; and every instant of my existence, *making two blades of grass to grow, where not one was found before*,—behold me at a desk, in the smoke, the fog, the din of Whitehall. 'Society has charms;'—true, and so has solitude to a mind employed. The die, however, is cast, and my steps may still be, metaphorically, said to be in the furrow." . . . .

In the year 1801, by an express order of the French Directory†, his works were translated, and published at Paris, in twenty volumes, octavo, under the title of "*Le Cultivateur Anglois;*" and in the same year, M. du Pradt dedicated to him his work, called, "*De l'Etat de la Culture en France.*"

In the year 1794, he engaged with the Board to draw up the County Reports, and accordingly he shortly afterwards published that of the county of Suffolk, and, in succession, those of Lincoln, Norfolk, Hertford, Essex, and Oxford: these reports are marked by that same sterling talent, which characterizes all his writings. In 1795 he published two political pamphlets, entitled, "*The Constitution safe without Reform,*" and "*An Idea of the present State of France.*" In the following year, he paid a very long visit to Mr. Burke, at his seat at Beaconsfield. In 1797, his youngest and favourite daughter died in a

* The salary was £400 per annum, with a house, free from all charge.

† Said to be chiefly by the advice of the Director, Carnot, who presented the Author with the translation.

decline: this was an event that produced in him a greater shock, and a more remarkable change in his habits and reflections, than any circumstance that had ever occurred. Death, under any shape, is a terrible monitor; but when he selects his victim from the ranks of youth and beauty, how awful and terrific is his image! From this period Mr. Young began to direct his thoughts to those subjects of religion, the contemplation of which had hitherto been incompatible with the objects of his busy and laborious life: he was now perplexed with many doubts and difficulties respecting the condition of the soul in a future state of existence, and, as it was contrary to his active habits of research to remain, quietly, in doubt upon any subject, until he had applied to every source likely to afford information, he immediately commenced an interesting correspondence with some of our more eminent divines and scholars, amongst whom the name of the venerable Bryant frequently appears. The publication, however, of Mr. Wilberforce's work on *Practical Christianity* seems to have produced a greater effect in settling his conflicting opinions than any other assistance which he had received, and it established in his mind that true reliance upon divine mercy, which gilded the evening of his life, and cheered him in his latter days of darkness and infirmity. But the change thus produced in the habits and opinions of Mr. Young, did not repress his ardour for his favourite pursuits, and in the year 1798 he printed a a letter, addressed to Mr. Wilberforce, "*On the State of the Public Mind;*" and, in 1800, a pamphlet, "*On the Question of Scarcity.*" In the same year he made several tours to ascertain the effects of enclosures, the results of which he published in his *Annals of Agriculture.* In 1804, the Bath and West of England Society adjudged their Bedfordian medal to him, for an essay "*On the Nature and Properties of Manures,*" a memoir which contains a vast store of new and valuable facts upon this important subject of agricultural economy. It ought also to be noticed, that in this year he received the present of a snuff-box, from Count Rostopchin, the celebrated Governor of Moscow, which was turned by himself out of a block of oak,

richly studded with diamonds, and bearing a motto in the Russian language, which signifies, "*From a Pupil to his Master*," thereby attesting the great services which he had derived from the writings and practices of Mr. Young: over this motto, three cornucopiæ appear, in burnished gold, which are so disposed as to form a cipher of A. Y.

In the year 1805, Novosilsoff, the Russian Embassador, requested Mr. Young to recommend a person who would undertake to survey the government of Moscow, and to draw up a report similar to those which had been published of the English counties. In consequence of this application, the son of Mr. Young immediately proceeded to Russia, and performed the required survey; but, on account of the state of exchange between the two countries, he was unable, without a considerable sacrifice, to convey the sum of money which he had received for his labours, to England; he was therefore induced to inves it in the purchase of an estate in the Crimea, and upon this spot he has resided ever since. It consists of 10,000 acres of the richest land in the empire of Russia; it was formerly the country-seat of General de Schutz, at which he entertained Catherine and Potemkin, in their progress through the Crimea. The estate is in the vicinity of Karagos, and is fully described by Pallas, in his *Travels through Southern Russia*, as being the first that was regularly cultivated since the occupation of Crim Tartary by the Russians.

In the year 1808, Mr. Young was complimented by the Board of Agriculture, with a medal of gold, "*For long and faithful services in Agriculture.*" Shortly after this period, his active pursuits received a severe check from the failure of his eyes; an incipient cataract betrayed itself, and he soon became unable to take his usual exercise: his digestion, therefore, became disordered, and I have no doubt but that the fatal disease which terminated his existence is to be attributed to this sudden change in his habits. It is a very remarkable fact, that, during his whole life, which was blessed with an uninterrupted share of health, he entertained the greatest horror of two diseases—blindness and the stone, and we find him afflicted

with the former at seventy years of age, after an unsuccessful operation in 1811, and that, at the advanced period of eighty, his life was terminated by the severe sufferings attendant upon the latter! Although his blindness deprived agriculture of an active and laborious investigator, yet the political economist continued to derive from his extensive knowledge and sound judgment, most valuable assistance; and he was continually consulted and examined upon various subjects which occupied the attention of Parliament. The Board of Agriculture also continued to profit by his assistance; he delivered before them a variety of lectures, upon the application of manures, and the improvement of waste lands, and on other subjects of practical importance, several of which were afterwards published by order of the Board. Nor did he abandon those habits of industry which had ever distinguished him: he rose every morning at five o'clock, and regularly heard the different new works read; he was also engaged in preparing for the press, an immense work, on the Elements and Practice of Agriculture, which contains his experiments and observations, made during a period of fifty years. The manuscript is bequeathed to his son and daughter; and it is to be hoped, that when the former returns from Russia, he will take measures for its speedy publication. Mr. Young also, at this time, published select passages from the religious works of Baxter and Owen, in two volumes, duodecimo, under the title of "*Baxteriana*," and "*Oweniana*." Mr. Young possessed a warm and generous heart, and his numerous acts of kindness and benevolence will be long remembered by the grateful inhabitants of Bradfield and the surrounding country. His house was always opened to the distressed, and his counsel and advice were rarely given without an accompanying boon, that might better enable the petitioner to profit by its application. His hall was crowded, every Sunday evening, with peasants, to whom he read the prayers of the Church of England, and dismissed them with a suitable exhortation.

The disease, of which Mr. Young died, was not suspected until about a week of his death—a circumstance which received

a very satisfactory explanation, from an examination of the body, after death. He was attended by Mr. Wilson, Mr. Chilver, and myself, and although the incurable nature of his disease defied every hope of permanent relief, yet his sufferings were greatly palliated by the resources of art, and he died without entertaining the least suspicion of the malady under which he suffered. Pious resignation cheered him in his illness, and not a murmur of complaint was heard to escape his lips. On the 12th of April, in the year 1820, at his house in Sackville-street, after taking a glass of lemonade, and expressing himself calm and easy, he expired. His remains were conveyed to Bradfield, and deposited in a vault in the church-yard.

I have thus offered a brief sketch of the principal labours of Mr. Arthur Young—a man who has filled a large space in the public eye, for a long series of years, but whose name and talents appear to have commanded greater notice and respect in foreign countries than in his own. It remains to be seen what mark of regard, what testimony of gratitude, his memory will receive from the Board of Agriculture, of which he has been so long the pride and ornament. That he has reflected lustre on the age and country in which he lived can be hardly denied; of what other philosopher can it be said—that, at one time, he entertained, under his humble roof, pupils of seven different nations, each of whom had been sent to him for instruction in agriculture, by his respective government. I was lately informed by his daughter, that the late Duke of Bedford breakfasted at Bradfield, on one of the mornings of a Newmarket race-meeting, and was met by pupils from Russia,—France,—America,—Naples,—Poland,—Sicily,—and Portugal. His numerous works are distinguished by vivacity of thought, quickness of imagination, bias to calculation, and fondness for political speculation; and had they been less successful, posterity might perhaps have regarded these traits of genius as fatal defects, and as pregnant sources of fallacy and disappointment.

Art. VIII.—*Select Orchideæ from the Cape of Good Hope.* [By J. B. Ker.]

[Continued from Page 222, Vol. VIII.]

Of Pterygodium *inversum* and Pterygodium *Volucris.*

Plate IV. *fig.* 1. Pterygodium inversum.

Pterygodium *inversum*, leaves subdistichous lanceolately lorate, spike close.

Pterygodium inversum. *Swartz act. holm.* 1800. *p.* 218. *Willdenow sp. pl.* 4. 58. *Thunb. flor. cap.* 1. 112. Ophrys inversa. *Thunb. prod.* 2.

Bulb undivided, ovate, surrounded with fibres, about the size of a bean. *Stem* round, thick, covered with leaves, a foot high. *Leaves* stem-clasping, distichous, convolute, lanceolately lorate, streaked, smooth, about eight, about a span in length, upper one shorter. *Flower* green, cernuous, with the appearance of being reversed, spike close, a span long. *Bractes* broad-lanceolate, pointed, concave, green, smooth, larger than the germens. *Corolla* of five *petals*, subringent; *casque* formed of the uppermost lanceolate concave *petal*, and the two inner lateral large obovate concave *ones* slightly connected together at the sides: *two outer front* (by the position of the flower *hinder*) *petals* deflected, ovately lanceolate, vertical, concave at the base, shorter than the former. *Label* adnate to the middle of the style, small, subspatulate, narrower at the base, bent back at the middle. *Anther* adnate to the style, cells distant, at the side of the label. *Style* short, broadish at the top, compressed, thick, obtuse, indented, streaked with black: *stigma* placed at the back below the cells of the anther. The flowers have a disagreeable smell, like that of some of the *Fungi.*

Plate IV. *fig.* 2. Pterygodium Volucris.

Pterygodium *Volucris*; leaves three; ovate; label hastate; style obcordate at the top.

Pterygodium Volucris. *Swartz act. holm.* 1800. 218. *Willd. sp. pl.* 4. 57. *Thunb. flor. cap.* 1. 109.

Ophrys Volucris. *Lin. suppl.* 403.
Ophrys triphylla. *Thunb. prod.* 2.

Bulb undivided, ovate, beset with fibres, about the size of a large pea. *Stem* round, fleshy, brittle, smooth, leafy, a span high, green. *Leaves* on the stem, three, alternate, stem-clasping and subcucullate, broad-ovate, obtuse, nerved, uprightly spreading, the lowermost leaf on the root, the largest about three inches long; the centre one (on the middle of the stem) about an inch long; uppermost very small, the length of a finger-nail. *Flowers* of a whitish green, about the length of a man's finger. *Bractes* broad-lanceolate, pointed, green. *Corolla* subringent, five-petalled: *casque* formed of the topmost linear obtuse almost upright petal and the two lateral inner ones, which are obovate, rounded at the end, upright, indented with an outer very broad inflected lobe, and an inner one which is slightly attached to the topmost petal: *the two outer lateral petals* ovate, pointed, concave, vertical: *Label* inserted near the base of the style, hastate, with the lateral lobes channelled, and, as well as the front one, pointed and spreading. *Anther* adnate to the style above the label: *cells* at the side of the style, diverging, oblong. *Style* short, widened at the top, indented: *stigma* at the back of the style.

The two figures now published conclude the valuable series of drawings of Orchideæ for which we are indebted to Sir Joseph Banks.

Art. IX. *Description of the Royal Gardens of Lahore. In a Letter to the Editor of the Quarterly Journal of Science, Literature, and the Arts, from* Captain Benjamin Blake. *of the Bengal Army.*

Sir,

Although I am aware that two or three descriptions of Shah Leemar (or Royal Oriental Gardens,) have at divers times appeared, such as those by Foster in his *Travels through Cashmere,*—Franklin in his *Present State of Dilhee,* and Elphinston's

Embassy to Cabul,—yet as those gardens described were not of the class of the Hanging Gardens, and, as during a residence in India, I was fortunate enough to make one of an embassy to Lahore, where I viewed the باغ شالامار or Royal Gardens of the Moghul emperors, situated between three and four miles east of the city of Lahore, in the Punjab, or Country of Five Waters, —considering a description of them may afford pleasure to your readers, who, no doubt, have heard of the splendid Hanging Gardens of Babylon, said to have been erected by order of Nebuchadnezzar to gratify his wife Amytis; and, though the gardens to be described in this paper are not of that splendid character, yet they certainly belong to the same class, thereby differing from the Royal Gardens generally found in India.

The embassy to Lahore, (headed by Mr. C. T. Metcalfe, Ambassador from the Honourable East India Company to Runjeet Sing, Chief of the Punjab,) had been encamped upon the plain, on the north-east side of the city of Lahore, and immediately opposite the palace of the Moghul emperors, that part of it erected by Arungzebe, towering above the rest of the buildings, and are particularly striking and deserving of notice for the many very beautiful latticed windows of white marble which it contains, the marble being wrought into an open work, resembling the trellis or open work of the ivory boxes which come from China. On Tuesday, 10th January, 1809, we quitted this plain, and entering the city, passed the eastern quarter, and through the Dilhee gate, which, as well as the walls generally, and this far-famed city itself, is decaying very fast under the hand of time, and its frequent accessary neglect. At a distance from the city, of a little more than three miles east, the road being bordered here and there with Mangoe groves, we arrived at the Shah Leemar gardens. The extreme length of these gardens, from south to north, is about five hundred yards, by a breadth of one hundred and thirty, or one hundred and forty. Mr. Metcalfe having obtained permission for his suite to view these gardens with him, we entered the west side of the northern or lowest garden, under a pretty good arched gateway, which appears to have been the only entrance from the

time they were first formed. There are three distinct gardens descending from the south; the highest, situated on remarkably rising ground, receives the Uslee canal* on its south side, through a small stone building, the front of which, towards the garden, has arches of a Gothic character; the back of the building being a blank wall, under which the canal first enters flowing into a marble basin of three feet diameter, in the centre of which is a fountain. The surplus water of the canal is conveyed by aqueducts, under a marble floor, and the water in the basin passes in a thin sheet over a white marble slab, (from which it falls into the garden) carved in scollops, the edges of the scollops being inlaid with black marble, in the fashion of fishes' scales. From this scollopped slab the water flows through the highest garden, and running under the marble floor of a Barah Dooree, or stone building of twelve arches, (being a square, having three to each face, as its name, in the language of the country, imports,) it falls to the second garden over a large surface of marble, sloping at an angle of about twenty degrees from the perpendicular. This fall consists of three fine slabs, each being ten feet by four, the whole displaying a sheet of water of ten feet deep by twelve feet in breadth, the marble being scollopped and inlaid with black, in a manner similar to the first slab already described. A most beautiful effect is produced by the rippling of the water over their scaly-marked indentations to its receptacle at the bottom of the inclined plain, in a reservoir of marble, fourteen feet by ten, and one foot in depth, having in its centre a Pulung, or couch, also of marble, with claw feet. On this couch the Moghul emperors were used to recline in the hot season, where, the waters rippling over the scallopped fall, they enjoyed the refreshing luxury of coolness from the falling water agitating the airy particles, and also the delightful sensation imparted by its murmurs over the uneven surface of the marble; thus rendering

* This canal is brought to these gardens over high grounds from the Rauvee river, a distance of upwards of sixty miles above the city of Lahore. It also irrigates the country through which it passes, and a considerable revenue is derived by the tax levied for its supply of water applied to agricultural purposes.

their situation, in the evenings of the sultry days, (when this aquatic couch is screened from the sun by an arcade in the garden immediately above,) most perfectly fitted to an enchanting repose, the exquisite luxury of which may be sufficiently appreciated by such as have resided in this warm climate. From this reservoir and its luxurious couch, the water flows in a gentle stream into a large quadrangular basin or tank, which occupies nearly the whole of this garden, having in its centre, a square insulated platform, or bank of earth, which contains some flowers: and around the tank is a border of flowers of eighteen or twenty feet in width, having, on the side nearest to the water, a narrow walk of not more than three feet.

The water, on leaving this tank, passes between marble slabs, laid horizontally, the upper ones forming the floor of an arcade twelve feet square, of which only three sides are arched. This three-sided arcade, erected over this passage of the water into the lower garden, (the walls of which rest upon this garden,) presents the appearance of an aquatic chamber, the water here again falling in thin sheets of three faces, and the walls containing a great number of recesses for lamps, whose glittering lustre under the falling water, displays a magical and peculiarly brilliant effect, which, with the addition of five fountains in this watery recess, produces an enchanting union of refreshing luxuries. The water flows, in the usual character of a stream, from this extremely cool recess through this lowest or northernmost garden, which is plentifully stored with large trees, among which are the apple, pear, and some very fine mangoes; the latter affording, from the luxuriance of their foliage, delightful groves, whose umbrageous protection from the scorching rays of the sun, renders this spot a most desirable and refreshing retreat. The upper gardens are laid out in a sufficiently tasteful manner, with fruit and flower-trees; among the latter we observed the Narcissus in great abundance. The present Chief of the Punjab, Runjeet Sing, has erected, in the highest garden, a Tye Khanah, or cool retreat for the hot season, which has somewhat disfigured it. The construction of this retreat is very simple, being a house of two rooms, one below ground, the

other above, and on a level with the ground. At one end of this building, on the space beneath the usual level of the ground, there is a well of water, towards which the lower room opens; and when it is requisite to cool this room, the following operation is put in action, *viz.*, at the top of the well there is a large wheel, over which pass two ropes parallel to each other, to which are suspended along the entire length of the ropes, reaching to a depth of two or three feet in the water, a succession of earthen pots; so that, when the wheel is put in motion, the buckets are drawn up full on one side, and, passing over the top of the well, return their contents again into it, the operation of which agitates the circumambient air, causing a rapid evaporation, thus rendering the chamber refreshingly cool.

During the encampment of the embassy at Lahore, (a period of three weeks,) we made frequent excursions in its neighbourhood, and within the extent of three to five miles, beheld numerous remains of the mansions of the Emirs, or nobles of the empire, of which there is scarcely a remaining vestige in the vicinity of Delhee, for there

پرده داري ميکند در قصر قيصر عنکبوت
بوم نوبت مي زند بر گنبذ افراسياب

"The spider holds the veil in the palace of Cæsar; the owl stands sentinel in the watch-tower of Afrasiab."

In one of these excursions, on the right bank of the Rauvee, we stumbled, as it were, upon a most magnificent mausoleum of the Emperor Jehangeer, nothing inferior to the celebrated Taj Muhul at Agrah. The building which contains this mausoleum is much larger than that at Agrah, though it is not, in the exterior, of so chaste and beautiful a design. The large piazzas which surround this immense mass of buildings contain numerous accommodations for pilgrims and other travellers, and are floored throughout with pudding-stone. There are various chambers within the edifice, some ornamented with paintings in fresco, tolerably well executed, particularly some of domestic scenes, of parties eating fruit, *&c.*, in a taste

evidently superior to any thing we can suppose the natives to have ever arrived at; and, therefore, were, most likely, designed by the artists who came from Italy to construct the tomb. The tomb itself is in the centre of the building, and is composed of the whitest marble, inlaid with mosaic work of cornelians, representing wreaths of flowers of the most beautiful hues; the cornelians being of such a variety of colours, that I counted sixteen differently coloured in the formation of one flower; and so exquisite is the execution of this mosaic, that the junction of one stone with the other was discernible only by a very near inspection. Around this edifice is a spacious court-yard, and a fine garden of orange and pomegranate trees, the whole encompassed by a good wall. The immense sum said to have been expended in the construction of this wall I dare not name, as it appears incredible. In the vicinity of this splendid sepulchre of the Emperor Jehangeer is the modest tomb of his beauteous, fascinating, and favourite Sultana, styled Noor Muhul, the Light of the Palace, and afterwards, Noor Jehan, the Light of the World. But she is better known to our English readers, since the publication of Moore's last and best poem, *Lalla Rookh*, where she is styled, the Light of the Haram. It may be satisfactory here to gratify the curiosity of your readers respecting this far-famed beauty, by giving some history of her birth and fortunes; and, in offering this, I know of no better mode to convey information, than by adding an extract from Dow's *History of Hindostan.*

" About the year 1586, Chaja Aiass, a native of the Western Tartary, left that country, to push his fortune in Hindostan. He was descended of an ancient and noble family, fallen to decay by various revolutions of fortune. He, however, had received a good education, which was all his parents could bestow. Falling in love with a young woman, as poor as himself, he married her; but he found it difficult to provide for her the very necessaries of life. Reduced to the last extremity, he turned his thoughts upon India, the usual resource of the needy Tartars of the North. He left privately friends who either would not or could not assist him, and turned his face to

a foreign country. His all consisted of one sorry horse, and a very small sum of money, which had proceeded from the sale of his other effects. Placing his wife upon the horse, he walked by her side. She happened to be with child, and could ill endure the fatigue of so great a journey. Their scanty pittance of money was soon expended; they had even subsisted for some days upon charity, when they arrived on the skirts of the Great Solitudes, which separate Tartary from the dominions of the family of Timur, in India. No house was there to cover them from the inclemency of the weather—no hand to relieve their wants. To return, was certain misery; to proceed, apparent destruction. They had fasted three days: to complete their misfortunes, the wife of Aiass was taken in labour. She began to reproach her husband for leaving his native country at an unfortunate hour; for exchanging a quiet, though poor life, for the ideal prospect of wealth in a distant country. In this distressed situation she brought forth a daughter. They remained in the place for some hours, with a vain hope that travellers might pass that way. They were disappointed: human feet seldom tread these deserts. The sun declined apace: they feared the approach of night; the place was the haunt of wild beasts; and should they escape their hunger, they must fall by their own. Chaja Aiass, in this extremity, having placed his wife on the horse, found himself so much exhausted that he could scarcely move. To carry the child was impossible: the mother could not even hold herself fast on the horse. A long contest began between humanity and necessity; the latter prevailed, and they agreed to expose the child on the highway. The infant, covered with leaves, was placed under a tree, and the disconsolate parents proceeded in tears. When they had advanced about a mile from the place, and the eyes of the mother could no longer distinguish the solitary tree under which her daughter had been left, she gave way to grief, and throwing herself from the horse to the ground, exclaimed, "My child, my child!" She endeavoured to raise herself; but she had no strength to return. Aiass was pierced to the heart. He prevailed upon

his wife to sit down. He promised to bring her the infant. He arrived at the place. No sooner had his eyes reached the child, than he was almost struck dead with horror. A black snake (say our authors) was coiled around it, and Aiass believed he beheld him extending his fatal jaws to devour the infant. The father rushed forward. The serpent, alarmed at his vociferation, retired into the hollow tree. He took up his daughter unhurt, and returned to the mother. He gave her child into her arms; and, as he was informing her of the wonderful escape of the infant, some travellers appeared, and soon relieved them of all their wants. They proceeded gradually, and came to Lahore.

" The Emperor Akbar, at the arrival of Chaja Aiass, kept his court at Lahore. Asiph Khan, one of that monarch's principal Omrahs, attended then the presence. He was a distant relation of Aiass, and he received him with attention and friendship. To employ him, he made him his own secretary. Aiass soon recommended himself to Asiph in that station; and, by some accident, his diligence and ability attracted the notice of the Emperor, who raised him to the command of 1,000 horse. He became, in process of time, Master of the Household; and his genius being even greater than his good fortune, he raised himself to the office and title of Aktimad-ul-Dowla, or High Treasurer of the Empire. Thus he, who almost perished through mere want in the desert, became, in the space of a few years, the first subject in India. The daughter who had been born to Aiass in the desert, received, as she grew up at Lahore, the name of Mher-ul-Nissa, or the Sun of Women. She had some right to the appellation, for in beauty she exceeded all the ladies of the East. In music, in dancing, in poetry, in painting, she had no equal among her own sex; her disposition was volatile, her wit lively and satirical, her spirit lofty and uncontrolled; she was married first to Sheri Afghan*, whose original name was Asta Jillŏ, and afterwards to Jehangeer.

* He received this title from having fought with and conquered a tiger in single combat.

Art. X.—*Experiments on the Alloys of Steel, made with a View to its Improvement. By* J. Stodart, Esq., *and* M. Faraday, Chem. Assistant at the Royal Institution.

In proposing a series of experiments on the alloys of iron and steel, with various other metals, the object in view was two-fold,—first, to ascertain whether any alloy could be artificially formed, better for the purpose of making cutting-instruments than steel in its purest state; and, secondly, whether any such alloys would, under similar circumstances, prove less susceptible of oxidation;—new metallic combinations for reflecting mirrors was also a collateral object of research.

Such a series of experiments were not commenced without anticipating considerable difficulties, but the facilities afforded us in the laboratory of the Royal Institution where they were made, have obviated many of them. The subject was new, and opened into a large and interesting field. Almost an infinity of different metallic combinations may be made according to the nature and relative proportions of the metals capable of being alloyed. It never has been shown by experiment, whether pure iron, when combined with a minute portion of carbon, constitutes the very best material for making edge tools; or whether any additional ingredient, such as the earths, or their bases, or any other metallic matter, may not be advantageously combined with the steel; and, if so, what the materials are, and what the proportion required to form the best alloy for this much desired and most important purpose. This is confessedly a subject of difficulty, requiring both time and patient investigation, and it will perhaps be admitted as some apology for the very limited progress as yet made.

By referring to the analysis of wootz, or Indian steel, (see *Journal*, Vol. VII., page 288,) it will be observed, that only a minute portion of the earths alumine and silex, could be detected, these earths (or their bases) giving to the wootz its peculiar character. Being satisfied as to the constituent parts

of this excellent steel, it was proposed to attempt making such a combination, and, with this view, various experiments were made. Many of them were fruitless: the successful method was the following. Pure steel in small pieces, and in some instances, good iron being mixed with charcoal powder were heated intensely for a long time; in this way they formed carburets, which possessed a very dark metallic grey colour, something in appearance like the black ore of tellurium, and highly crystalline. When broken, the facets of small buttons, not weighing more than 500 grains, were frequently above the eighth of an inch in width. The results of several experiments on its composition, which appeared very uniform, gave 94.36 iron, + 5.64 carbon. This being broken and rubbed to powder in a mortar, was mixed with pure alumine, and the whole intensely heated in a close crucible for a considerable time. On being removed from the furnace, and opened, an alloy was obtained of a white colour, a close granular texture, and very brittle: this, when analyzed, gave 6.4 per cent. alumine, and a portion of carbon not accurately estimated. 700 of good steel, with 40 of the alumine alloy, were fused together, and formed a very good button, perfectly malleable; this, on being forged into a little bar, and the surface polished, gave, on the application of dilute sulphuric acid, the beautiful damask which will presently be noticed as belonging peculiarly to wootz. A second experiment was made with 500 grains of the same steel, and 67 of the alumine alloy, and this also proved good; it forged well, and gave the damask. This specimen has all the appreciable characters of the best Bombay wootz.

We have ascertained, by direct experiment, that the wootz, although repeatedly fused, retains the peculiar property of presenting a damasked surface, when forged, polished, and acted upon, by dilute acid. This appearance is apparently produced by a dissection of the crystals by the acid; for though by the hammering the crystals have been bent about, yet their forms may be readily traced through the curves, which the twisting and hammering have produced. From this uniform appearance on the surface of wootz, it is

highly probable, that the much-admired sabres of Damascus are made from this steel; and, if this be admitted, there can be little reason to doubt, that the damask itself is merely an exhibition of crystallization. That on wootz it cannot be the effect of the mechanical mixture of two substances, as iron and steel, unequally acted upon by acid, is shown by the circumstance of its admitting re-fusion, without losing this property. It is certainly true, that a damasked surface may be produced by welding together wires of iron and steel; but if these welded specimens are fused, the damask does not again appear. Supposing that the damasked surface is dependant on the development of a crystalline structure, then the superiority of wootz in shewing the effect, may fairly be considered as dependant on its power of crystallizing, when solidifying, in a more marked manner, and in more decided forms than the common steel. This can only be accounted for by some difference in the composition of the two bodies, and as it has been stated that only the earths in small quantities can be detected, it is reasonable to infer, that the bases of these earths being combined with the iron and carbon render the mass more crystallizable, and that the structure drawn out by the hammer, and confused, (though not destroyed,) does actually occasion the damask. It is highly probable, that the wootz is steel, accidentally combined with the metal of the earths, and the irregularity observed in different cakes, and even in the same cake, is in accordance with this opinion. The earths may be in the ore, or they may be derived from the crucible in which the fusion is made.

In making the alumine alloy for the imitation of wootz, we had occasion to observe the artificial formation of plumbago. Some of the carburet of iron before mentioned having been pounded and mixed with fresh charcoal, and then fused, was found to have been converted into perfect plumbago. This had not taken place throughout the whole mass; the metal had soon melted, and run to the bottom; but having been continued in the furnace for a considerable time, the surface of the button had received an additional portion of charcoal,

and had become plumbago. It was soft, sectile, bright, stained paper, and had every other character of that body; it was indeed in no way distinguishable from it. The internal part of these plumbago buttons was a crystalline carburet: a portion of it having been powdered, and fused several times with charcoal, at last refused to melt, and on the uncombined charcoal being burnt away by a low heat, it was found that the whole of the steel had been converted into plumbago: this powder we attempted to fuse, but were not successful.

It will appear by the following experiment, that we had formed artificial wootz, at a time when this certainly was not the object of research. In an attempt to reduce titanium, and combine it with steel, a portion of menachanite was heated with charcoal, and a fused button obtained. A part of this button was next fused with some good steel; the proportions were 96 steel, 4 menachanite button. An alloy was formed, which worked well under the hammer; and the little bar obtained was evidently different from, and certainly superior to, steel. This was attributed to the presence of titanium, but none could be found in it; nor indeed was any found even in the menachanite button itself. The product was iron and carbon, combined with the earths or their bases, and was in fact excellent wootz. A beautiful damask was produced on this specimen by the action of dilute acid. Since this many attempts have been made to reduce the oxide of titanium; it has been heated intensely with charcoal, oil, *&c.*, but hitherto all have failed, the oxide has been changed into a black powder, but not fused. When some of the oxide was mixed with steel filings, and a little charcoal added, on being intensely heated the steel fused, and ran into a fine globule which was covered by a dark coloured transparent glass, adhering to the sides of the crucible. The steel contained no titanium, the glass proved to be oxide of titanium, with a little oxide of iron. These experiments have led us to doubt whether titanium has ever been reduced to the metallic state. From the effects of the heat upon the crucibles, which became soft, and almost fluid, sometimes, in fifteen minutes, we had in fact no reason to suppose the degree of heat inferior to any before ob-

tained by a furnace :—that used in these last experiments, was a blast furnace, supplied by a constant and powerful stream of air; the fuel good Staffordshire coke, with a little charcoal; both Hessian and Cornish crucibles were used, one being carefully luted into another,—and even three have been united, but they could not be made to stand the intense heat.

Meteoric iron, is, by analysis, always found to contain nickel. The proportions are various, in the specimens that have been chemically examined. The iron from the Arctic regions was found to contain three per cent only of nickel, (see *Journal*, Vol. VI. p. 369,) while that from Siberia gave nearly 10 per cent. With the analysis of this last we are favoured by J. G. Children, Esq., and, having permission from that gentleman, we most willingly insert the account of his very accurate process.

37 grains of Siberian meteoric iron gave 48.27 grains of peroxide of iron, and 4.52 grains of oxide of nickel. Supposing the equivalent number for nickel to be 28, these quantities are equal to

Iron	33.69
Nickel	3.56
	37.25

Supposing the quantities to be correctly

Iron	33.5
Nickel	3.5
	37.

the proportions per cent are

Iron	90.54
Nickel	9.46
	100.00

A second experiment on 47 grains, gave 61 grains of peroxide of iron=42.57 iron. The ammoniacal solution of nickel was lost by an accident; reckoning from the iron, the quantities per cent are,

Iron	90.57
Nickel	9.42
	99.99

A third experiment on 56 grains, gave 73.06 grains peroxide

of iron $=$ 50.99 iron, and 5.4 of oxide of nickel. $=$ 4.51 nickel, or per cent,

Iron	91.00
Nickel	8.01
Loss	0.99
	100.00

The mean of the three gives 8.96 per cent of *nickel.*

The meteoric iron was dissolved in aqua regia, and the iron thrown down by pure ammonia, well washed, and heated red.

In the first experiment the ammoniacal solution was evaporated to dryness, the ammonia driven off by heat, and the oxide of nickel re-dissolved in nitric acid, and precipitated by pure potassa, the mixture being boiled a few seconds.

In the third experiment the nickel was thrown down from the ammoniacal solution at once by pure potassa. The first method is best, for a minute portion of oxide of nickel escaped precipitation in the last experiment, to which the loss is probably to to be attributed.

All the precipitates were heated to redness. J. G. C.

We attempted to make imitations of the meteoric irons with perfect success. To some good iron (horseshoe nails,) were added three per cent. of pure nickel; these were enclosed in a crucible, and exposed to a high temperature in the air-furnace for some hours. The metals were fused, and on examining the button, the nickel was found in combination with the iron. The alloy was taken to the forge, and proved under the hammer to be quite as malleable and pleasant to work as pure iron; the colour when polished rather whiter. This specimen, together with a small bar of meteoric iron, have been exposed to a moist atmosphere; they are both a little rusted. In this case it was omitted to expose a piece of pure iron with them; it is probable that, under these circumstances, the pure iron would have been more acted upon.

The same success attended in making the alloy to imitate the Siberian meteoric iron agreeably to Mr. Children's analysis. We fused some of the same good iron, with 10 per cent. nickel; the

metals were found perfectly combined, but less malleable, being disposed to crack under the hammer. The colour when polished had a yellow tinge. A piece of this alloy has been exposed to moist air for a considerable time, together with a piece of pure iron; they are both a little rusted, not, however, to the same extent; that with the nickel being but slightly acted upon, comparatively to the action on the pure iron; it thus appears that nickel, when combined with iron, has some effect in preventing oxidation, though certainly not to the extent that has at times been given to it. It is a curious fact, that the same quantity of the nickel alloyed with steel, instead of preventing its rusting, appeared to accelerate it very rapidly.

Platinum and rhodium have, in the course of these experiments, been alloyed with iron, but these compounds do not appear to possess any very interesting properties. With gold we have not made the experiment. The alloys of other metals with iron, as far as our experience goes, do not promise much usefulness. The results are very different when steel is used; it is only, however, of a few of its compounds that we are prepared to give any account.

Together with some others of the metals, the following have been alloyed with both English and Indian steel, and in various proportions; platinum, rhodium, gold, silver, nickel, copper and tin.

All the above-named metals appear to have an affinity for steel sufficiently strong to make them combine; alloys of platinum, rhodium, gold and nickel, may be obtained when the heat is sufficiently high. This is so remarkable with platinum, that it will fuse when in contact with steel, at a heat at which the steel itself is not affected.

With respect to the alloy of silver, there are some very curious circumstances attending it. If steel and silver be kept in fusion together for a length of time, an alloy is obtained, which appears to be very perfect while the metals are in the fluid state, but on solidifying and cooling, globules of pure silver are expressed from the mass, and appear on the surface of the button. If an alloy of this kind be forged into a bar, and then dissected by

the action of dilute sulphuric acid, the silver appears, not in combination with the steel, but in threads throughout the mass; so that the whole has the appearance of a bundle of fibres of silver and steel, as if they had been united by welding. The appearance of these silver fibres is very beautiful; they are sometimes $\frac{1}{8}$ of an inch in length, and suggest the idea of giving mechanical toughness to steel, where a very perfect edge may not be required.

At other times, when silver and steel have been very long in a state of perfect fusion, the sides of the crucible, and frequently the top also, are covered with a fine and beautiful dew of minute globules of silver; this effect can be produced at pleasure. At first we were not successful in detecting silver by chemical tests in these buttons; and finding the steel uniformly improved, were disposed to attribute its excellence to an effect of the silver, or to a quantity too small to be tested. By subsequent experiments we were, however, able to detect the silver, even to less than 1 in 500.

In making the silver alloys, the proportion first tried was 1 silver to 160 steel; the resulting buttons were uniformly steel and silver in fibres, the silver being likewise given out in globules during solidifying, and adhering to the surface of the fused button; some of these when forged gave out more globules of silver. In this state of mechanical mixture the little bars, when exposed to a moist atmosphere, evidently produced voltaic action, and to this we are disposed to attribute the rapid destruction of the metal by oxidation, no such destructive action taking place when the two metals are chemically combined. These results indicated the necessity of diminishing the quantity of silver, and 1 silver to 200 steel was tried. Here, again, were fibres and globules in abundance; with 1 to 300, the fibres diminished but still were present; they were detected even when the proportion of 1 to 400 was used. The successful experiment remains to be named. When 1 of silver to 500 steel were properly fused, a very perfect button was produced; no silver appeared on its surface; when forged and dissected by an acid, no fibres were seen, although examined by a high

magnifying power. The specimen forged remarkably well, although very hard; it had in every respect the most favourable appearance. By a delicate test every part of the bar gave silver. This alloy is decidedly superior to the very best steel, and this excellence is unquestionably owing to combination with a minute portion of silver. It has been repeatedly made, and always with equal success. Various cutting tools have been made from it of the best quality. This alloy is perhaps only inferior to that of steel with rhodium, and it may be procured at a small expense; the value of silver, where the proportion is so small, is not worth naming; it will probably be applied to many important purposes in the arts. An attempt was made to procure the alloy of steel with silver by cementation; a small piece of steel wrapped in silver leaf, being 1 to 160, was put into a crucible, which being filled up with pounded green glass, was submitted to a heat sufficient to fuse the silver; it was kept at a white heat for three hours. On examining it, the silver was found fused, and adhering to the steel; no part had combined. The steel had suffered by being so long kept at a high temperature. Although this experiment failed in effecting the alloy of steel with silver, there is reason to believe that with some other metals, alloys may be obtained by this process; the following circumstance favours this suggestion. Wires of platinum and steel, of about equal diameter, were packed together, and, by an expert workman, were perfectly united by welding. This was effected with the same facility as could have been done with steel and iron. On being forged, the surface polished, and the steel slightly acted on by an acid, a very novel and beautiful surface appeared, the steel and platinum forming dark and white clouds; if this can be effected with very fine wires, a damasked surface will be obtained, of exquisite beauty. This experiment, made to ascertain the welding property of platinum, is only named here in consequence of observing that some of the largest of the steel clouds had much the appearance of being alloyed with a portion of the platinum. A more correct survey of the surface, by a high magnifying power, went far to confirm

this curious fact; some more direct experiments are proposed to be made on this apparent alloy by cementation.

The alloys of steel with platinum, when both are in a state of fusion, are very perfect, in every proportion that has been tried. Equal parts by weight form a beautiful alloy, which takes a fine polish, and does not tarnish; the colour is the finest imaginable for a mirror. The specific gravity of this beautiful compound is 9.862.

90 of platinum with 20 of steel, gave also a perfect alloy, which has no disposition to tarnish, the specific gravity 15.88; both these buttons are malleable, but have not yet been applied to any specific purpose.

10 of platinum to 80 of steel, formed an excellent alloy. This was ground and very highly polished to be tried as a mirror; a fine damask, however, renders it quite unfit for that purpose.

The proportions of platinum that appear to improve steel for edge instruments, are from 1 to 3 per cent. Experience does not yet enable us to state the exact proportion that forms the best possible alloy of these metals; 1.5 per cent. will probably be very nearly right. At the time of combining, 10 of platinum with 80 steel, with a view to a mirror, the same proportions were tried with nickel and steel; this too had the damask, and consequently was unfit for its intention. It is curious to observe the difference between these two alloys, as to susceptibility for oxygen. The platinum and steel, after laying many months, had not a spot on its surface, while that with nickel was covered with rust; they were in every respect left under similar circumstances. This is given as an instance, shewing that nickel with steel is much more subject to oxidation than when combined with iron.

The alloys of steel with rhodium are likely to prove highly valuable. The scarcity of that metal must, however, operate against its introduction to any great extent. It is to Dr. Wollaston we are indebted, not only for suggesting the trial of rhodium, but also for a liberal supply of the metal, as well as much valuable information relative to fuel, crucibles, *&c.*; this liberality enables us to continue our experiments on this alloy;

these, with whatever else may be worth communicating, will be given in a future number of this *Journal.* The proportions we have used are from 1 to 2 per cent. The valuable properties of the rhodium alloys are hardness, with sufficient tenacity to prevent cracking either in forging or in hardening. This superior hardness is so remarkable, that in tempering a few cutting articles made from the alloy, they required to be heated full 30° F. higher than the best wootz, wootz itself requiring to be heated full 40° above the best English cast steel. Thermometrical degrees are named, that being the only accurate method of tempering steel.

Gold forms a good alloy with steel. Experience does not yet enable us to speak of its properties. It certainly does not promise to be of the same value as the alloys of silver, platinum, and rhodium.

Steel with two per cent. of copper, forms an alloy. Steel also alloys with tin. Of the value of these we have doubts. If, on further trial, they, together with other combinations requiring more time than we have been able to bestow on them, should prove at all likely to be interesting and useful, the results will be frankly communicated.

Our experiments have hitherto been confined to small quantities of the metals, seldom exceeding 2,000 grains in weight; and we are aware that the operations of the laboratory are not always successful when practised on a large scale. There does not, however, appear to be any good reason why equal success may not attend the working on larger masses of the metals, provided the same diligence and means are employed.

From the facility of obtaining silver, it is probable that its alloy with steel is the most valuable of those we have made. To enumerate its applications, would be to name almost every edge-tool. It is also probable that it will prove valuable for making dies, especially when combined with the best Indian steel. Trial will soon be made with the silver in the large way, and the result, whatever it may be, will be candidly stated.

Table of Specific Gravities of Alloys, &c., mentioned in the preceding Paper.

Iron, unhammered,	7.847
Wootz, unhammered, (Bombay)	7.665
Wootz, tilted, (Bombay)	7.6707
Wootz, in cake, (Bengal)	7.730
Wootz, fused and hammered, (Bengal)	7.787
Meteoric iron, hammered,	7.965
Iron, and 3 per cent. nickel,	7.804
Iron, and 10 per cent. nickel,	7.849
Steel, and 10 per cent. platinum, (mirror)	8.100
Steel, and 10 per cent. nickel, (mirror)	7.684
Steel, and 1 per cent. gold, hammered,	7.870
Steel, and 2 per cent. silver, hammered,	7.808
Steel, and 1.5 per cent. platinum, hammered,	7.732
Steel, and 1.5 per cent. rhodium, hammered,	7.795
Steel, and 3 per cent. nickel, hammered,	7.750
Platinum 50, and steel 50, unhammered*,	9.862
Platinum 90, and steel 20, unhammered†,	15.88
Platinum, hammered and rolled,	21.25

Art. XI. *On the Attempts recently made to introduce the Shawl Goat into Britain. By* J. Mac Culloch, M.D., F.R.S., *&c. In a Letter to the Editor.*

Dear Sir,

As the attempts to introduce the Thibet goat into this country are not generally known, your readers may perhaps be interested by the following brief account of these trials, and of the results which have attended them. It may serve the further purpose, of inducing those, who have the means of procuring this animal, and estates fitted for its habitation, to contribute

* The calculated mean specific gravity of this alloy is 11.2723 assuming the specific gravity of platinum and steel, as expressed in this Table.

† The calculated mean specific gravity of this alloy is 16.0766.

their efforts towards the accomplishment of this object. Parallel attempts, it is well known, have also been recently made in France; but, with what success, we are not yet thoroughly informed, although there is considerable reason to believe, that similar failures have there taken place, and from the same causes which have hitherto rendered our own efforts unsuccessful.

In relating the history of these experiments, it will therefore be useful to add such information as could be procured, respecting the treatment of these animals, both in this country and in their native mountains; as it may point out some of the errors to be avoided, and some of the means to be pursued, to ensure at least some chance of better success than has yet been experienced with regard to the naturalization of this interesting and valuable creature. It will be a sufficient apology for the defective and unsatisfactory nature of these observations, to recollect, that our own experience is as yet very limited, and that the information which we have procured from India is not much more accurate or full. It is unnecessary to make any remarks on the probable advantages to be derived from the introduction of a new species of produce, applicable to a manufacture much in demand; as, on that subject, your readers are fully competent to form a correct judgment for themselves. If this communication shall serve no other purpose, it will probably induce others to convey to the public, through the same channel, whatever information they may possess on the same subject, and which, for want of knowing where it may exist, is inaccessible to your present correspondent.

Your readers need not be informed, that the original flock of the Thibet goats sent to Bengal, was procured by the exertions of Mr. Moorcroft and Lieutenant Hearsay, in their interesting journey to the source of the Ganges, of which the account was published in the *Asiatic Researches*. A selection from these was sent, in the year 1815, to the Duke of Athol, but, by an oversight, eventually unfortunate, the males were sent by one ship and the females by another. The former were lost at sea, and, of the latter, four only arrived at Blair. One of these proved to be pregnant, but the kid was unfortunately produced

dead. All these animals were unhealthy, although feeding freely on an excellent pasture, in a dry and warm summer, with the power of resorting to shelter at night. No particular directions regarding their treatment having been received, nor any knowledge communicated respecting the diseases to which they were subject, either in their native climate or after their transportation to Bengal, no precautions were adopted with respect to them, nor any rational plan of cure attempted. But it must be remarked, that none of this flock were subject to that disorder of the feet, which, in a subsequent one, appeared to be the chief cause of their distress. It is not unlikely that their ill health might have been prevented by the use of certain precautions, which will be mentioned when the mode of managing them in India is described.

Of these four, two began to shew marks of an eruptive disease, resembling the *scab* in sheep, after they had been in the pastures for the space of a month or six weeks; and the usual remedies were employed without success, as the disorder continued to increase till the period of their death. But the other two, which shewed no marks of disease, equally pined away and lost their appetites; and, in the course of the summer, the whole flock sickened and died in succession. No change of food, except that of a free access to hay, was attempted; but, like other goats, they shewed a great desire to eat the leaves of any branches of trees that were presented to them. On inquiring respecting the disease abovementioned, I was unable to discover that it was known in their native country or in Bengal; but as our information respecting their habits is still very limited, it may possibly be one to which they are subject. It is at least certain, that, even in their native mountains, they are in that high state of domestication which produces artificial habits and the diseases of civilization; and it is probable, that with more attention to their treatment, and more knowledge of their habits, some of the failures which have taken place in this country may hereafter be prevented.

No directions had been transmitted respecting the management of the fleeces, or the period or mode of shearing them,

and the account of Mr. Moorcroft's journey was not then arrived in this country. They were therefore suffered to shed their wool in the natural manner, and this process took place about the middle of August, continuing for a period of two or three weeks. It did not come off in large entangled flakes, as in the sheep, but in small portions; and to prevent it from being lost, was pulled away by the fingers as fast as it became loose. It may be useful to remark, that few of the long hairs came away with the wool; the rough coat of the animal continuing to appear unchanged during the whole of the process.

In Tartary, where the coat is shorn, the hairs and wool are removed together; and the separation of these, in the mode there adopted, is attended with considerable labour, and, consequently, with an expense which would, in this country, be a serious diminution of the value of the produce. As there were then no specimens of native imported wool to be procured in this country, and perhaps no one competent to judge of its nature, even if comparative samples could have been obtained, since the stapling even of common wool with accuracy requires a degree of experience which confines it to a few hands, it was impossible to know whether it had suffered by this natural process. If that should not be the case, it is obvious that much of the labour required in extracting the hair would be saved; but as, even in their native hills, this mode of obtaining the wool is not adopted, although the animals are tame, and collected daily by the goatherds, it is probable that experience has taught them the necessity of resorting to the process of shearing.

A considerable quantity of fine wool was thus obtained, but, from some of it having been lost by neglect, from the diseased state of the skin in two of the animals, and from the death of the whole occurring about this time, the weight of the produce was not estimated. The colours of this wool were white and pale brown; the variety of goat of which this small flock consisted being white with brown patches, very much resembling those of the common brown and white spaniel, and disposed in a similar manner.

In the summer of 1816, another female, with a male, arrived at Dunkeld in good health, and they were placed in a small paddock; as, from their propensity to browsing, they could not be left at large in the pleasure grounds, and it was not judged safe to suffer them to range among the hills with the sheep. These continued in a general state of good health during the winter, having access to shelter, and in 1817 the female produced a kid. Thus far they appear to have become accustomed to their new mode of life, and to a change, first from the cold and dry climate of their own mountains to that of Calcutta, and finally to the rich pasture and partial confinement of a situation which is remarkably rainy, and, for Scotland, warm. In the progress of time, however, they began to shew marks of ill health, denoted by a loss of appetite, attended by a stupid and melancholy look, which lasted for some days and then subsided. No disease of the skin occurred in these, but the male became frequently stiff in the limbs, so as to move with difficulty. This disorder, however, subsided again as it arose, without any means being tried for its cure, and it probably was the consequence of wet weather, which it is known that these animals cannot endure with impunity, even in their native climate.

Both the male and female, but the former in particular, were also much incommoded by the rapid growth of their hoofs, which, in the male, at length proceeded to such an extremity as to prevent him from grazing except on his knees. At the same time the joints of the knees gradually enlarged, and the whole of the fore limbs became nearly crippled. It is probable that this male was an aged animal, as he bore other marks indicating it, and that his death, which took place shortly afterwards, was accelerated by that natural cause. This incommodious growth of the feet must be attributed to the soft pasture in which they were kept: provision appearing to be made by nature for a rapid growth of horn in all the goat tribe, to enable them to bear the rocky ground which they are destined to occupy. There is no doubt that it would have been obviated by the choice of a better situation, had that been possible; and

that, even in that to which they were confined, it might have been prevented by paring; a process, which, it is understood, it has been found necessary to adopt, in certain cases, in India.

Subsequently to the death of the male, the kid also died, having attained its full growth, without any apparent cause of disease; and, to prevent the total loss of the breed, a cross was proposed with a native male goat, which resembled the female in its general form and appearance. This project, however, was abandoned, unfortunately, as it would have been desirable to know whether a hardier breed might not have been produced, possessed at least of a sufficient share of the properties of the pure Thibet goat to have rendered it a valuable acquisition.

In the summer of 1819, the female, which had for some time shewn the same marks of rheumatism and general ill health by which the male was affected, died. Thus the second attempt to naturalize them at Blair and Dunkeld, also failed.

It is probable that both these failures must be attributed, partly to the want of a sufficient variety of food, and, possibly, to the quality of a pasture much richer than that to which they are destined by nature. But it appears also to have arisen, in a great degree, from the rainy nature of the Highland climate; a very large proportion of the days, both of summer and winter, being wet, and the rains often continuing for many weeks without intermission. In Thibet, it appears that the climate is dry, the alternation being that of fair weather with snow, and not with rain. If this should be the cause, and that, by successive breeding, the shawl-goat cannot be inured to bear wet weather, it is probable that all attempts to naturalize it in Scotland will prove unavailing. It is worthy of remark on this subject, that, in some attempts to naturalize the reindeer at Blair, the same consequences followed; the animals sickening in the rainy season, and at length dying, apparently from the effects of protracted wet weather; but in some measure also, it was suspected, from the richness of the pasture.

No attempt was made to shear these animals, more than the preceding, but the wool was collected as it dropped off or hung

loose on their sides. On comparing it with specimens imported by the East India Company, no difference could be perceived by an ordinary judge of common wool, either in the length or fineness of the staple. Those who had charge of these goats unfortunately neglected to remark whether the kid of this breed produced the same wool, for quantity or quality, as the original animals, or in what respect, in both ways, it differed; a remark which it would have been very important to make, as, although the imported animals should prove incapable of being habituated to the climate, it would have been desirable to know whether the progeny was capable of perpetuating the qualities of the original stock.

With these two trials, the attempts made to introduce the shawl-goat by the Duke of Athol, have for the present terminated. But some experience has been gained for future trials; and some additional knowledge of their habits, recently procured from India, will, with the assistance of that experience, give an additional chance of success to the next experiments that may be made on this subject.

In 1817, a flock was sent to Mr. Dunlop, of Balnakiel, in Sutherland. Some of these died on the passage, but the remainder, consisting of a male, three females, and a kid produced on board of the ship, arrived at his farm in good health. In the autumn of that year, I found them thriving and free from diseases, and I was afterwards informed that in the following summer they still continued well. Since that period, I have neither had an opportunity of seeing them, nor of learning what their fate has been.

This flock was entirely black; and, in India, it is considered the most valuable variety, as the natural black wool is preferred to that which is dyed, and even to the white. It is of a finer and softer quality, and the shawls manufactured from it fetch a higher price in the market than any others; partly, it is probable, on account of their comparative scarcity.

The situation of Balnakiel is in the parish of Diurness, a few miles to the eastward of Cape Wrath, and the climate is peculiarly mild and rainy. The pasture is exceedingly rich, on a

calcareous soil, and will probably be found as ill adapted to them as those of Blair or Dunkeld.

If this flock should have thriven and propagated in this place, it will be a sufficient earnest of the possibility of naturalizing them in other parts of Scotland; but, respecting this, as I already remarked, I have had no means of procuring any information.

The last attempt made in Scotland to introduce and propagate these animals was by Mr. Macpherson Grant, the present member for Sutherland.

A pair was procured from the East India Company, in the autumn of 1816, and they were allowed to feed about the house of Invereshie during that winter in the ordinary pasture; having, at the same time, access to the hay-stack, as the first flock already mentioned had at Blair. In the summer of 1817, they continued in health, and were sent up to the high ridge of mountains which here separates the counties of Inverness and Aberdeen. To this mode of treatment is probably to be attributed the superior health of this pair, and their having escaped, in a considerable degree, that disease of the feet which proved so troublesome to those kept in the soft pastures at Dunkeld.

In October, they were again brought down to the house, and, in February 1818, the female produced twins, which, unfortunately, proved to be both males. The young throve remarkably well, and the female was fed on corn and turnips, without any apparent inconvenience, during the remainder of that winter. They were not sent up to the high hills in this summer, but allowed to feed about the low grounds at Invereshie, where they continued to thrive; having then passed two winters, and one complete summer, with every prospect of being in time thoroughly inured to the climate. But, in the middle of the May of 1818, the female began to droop, and, before the end of that month, she died; without any cause having been assigned for her death by those who, in Mr. Grant's absence, had the charge of her. It is not unlikely, however, that this event may have arisen from too

full a diet; the only error which appears to have been committed in the treatment of these animals; this experiment having, on the whole, been far more successful than those carried on at Blair and Dunkeld, and giving hopes of future success whenever the management shall be better understood, and when, by an increase of the numbers subjected to trial, occasional contingencies will be of little moment.

It is a sufficient proof of the general healthiness of this female, that, on being opened, she was found to be again pregnant with twins, a male and female; and, had not the cause above suspected, or some other unknown contingency, destroyed her, it is probable, that a native flock would at length have been raised at Invereshie by these efforts.

The males, which continue to thrive, passed the summer of 1819 in the hills, and the old one was long absent, having wandered away from the others, but was recovered before the winter. As these also remain in health after so long a probation of the oldest, there is little reason to doubt that he has become fully habituated to the climate; and that the two young ones are still more perfectly naturalized from the advantages of their birth in it. Unfortunately, no female has since been procured, so that it yet remains a doubt whether this experiment, so long carried on under favourable auspices, will ultimately succeed so as to establish a naturalized breed.

It is necessary here to remark, that, in the first year, the original pair showed the same disease of the skin which occurred in those at Blair. The wool was injured, in consequence, in the first crop, but the animals afterwards recovered, and continued clean. The feet also became tender while in the lower grounds, but, as already observed, without growing to the inconvenient length which they did in the animals kept at Dunkeld. This disorder however subsided in the summer, when they had access to the rocky hills, and showed the necessity of keeping them on ground of this quality, or, where that is not practicable, of paring their hoofs occasionally as a substitute for the natural process of wear. The necessity of this, it was already remarked, has even been observed in

India, and the knowledge of it will afford a useful hint to those who may undertake to prosecute the same experiment.

It is also important to remark, for the benefit of future cultivators of this goat, that they were partial to clean pasture, and were very unwilling to feed where the sheep had been. Hence the necessity of keeping them, as much as possible, separate, or of putting them on pastures so extensive as to diminish this inconvenience. It was also remarked, that they fed greedily on docks, and, as might be expected, were very destructive to the plantations, whenever they could get access to them.

Such are the results of the attempts hitherto made in Scotland towards the accomplishment of this object; and, at present, there appears no immediate prospect of renewing them. In England, nothing has yet been done on this subject, although I am informed at the India-house, that a male and female, sent to Lord Ranelagh at Fulham, are still alive there. The last arrival in this country was that of a male and female in March last, (1820,) but they both died shortly after landing.

P. S. I shall conclude this letter with an account of those circumstances respecting their habits and treatment, and their produce, which may either be useful or interesting to those who may think this object worthy of their attention. As this information was chiefly procured from the Marchioness of Hastings, who interested herself strongly in the subject, it is to be presumed that it is worthy of all reliance.

This animal is a native of that part of the mountains of Thibet which lies near to the region of perpetual snow, and of which the actual elevation, although very great, has not yet been determined in such a manner as to have satisfied the doubts of all parties. The climate is subject to sudden changes, although it does not appear that the summer temperature is ever high; and as that of winter is below the freezing point, the water which then falls is in the form of snow, not of rain. Hence it is understood to be a dry climate,

What the exact state of the summer, however, may be, we are not thoroughly informed; and it is probable, that too much stress has been laid on this circumstance in the fears which have been entertained respecting the naturalization of the animal in Scotland; as Mr. Grant's flock seems to have been thoroughly inured to a district which, both in summer and winter, is subject to frequent rains. There is indeed no reason to fear, from the analogy of many other animals which are in time educated to bear all climates, that this also may become habituated to one so different from that to which it belongs. What effect such a change may have on the wool, is another and an important question, which can however only be determined by experience. Some prospective judgment may perhaps be formed respecting this subject, by the consequences produced by similar alterations in the case of Merino sheep; but I am not aware that a difference in the quantity of rain is supposed to have any effect in altering the quality of their wool.

No accurate account has been yet received of the range of temperature in those regions inhabited by the Thibet goat, nor of the mean annual heat; so that it is impossible to institute any comparison between that important circumstance and the climate of Scotland. It is a natural consequence of transferring a deep-furred animal from a cold to a warm climate, that its fur should be diminished in quantity, as well as in the fineness of its quality. This change has accordingly been found to occur in India to those goats which have been brought down to the plains of Bengal; but the return to a colder region soon restores their wool to its pristine condition. Yet there is so wide a difference between the temperature of Scotland and that of Bengal, that no fears need be entertained of any change to this extent; while the permanence of many of the finer-wooled sheep, under a considerable range of climate, renders it probable, that the loss of quality which the fleeces might experience in Scotland, would not be such as to deprive them of their value, should it even in some degree diminish the quantity and quality of the produce.

It must, however, be evident, from both the preceding considerations, that the eastern parts of Scotland are better adapted for the cultivation of this goat than the western; since, if an irregular line be drawn between Perth and Inverness, it will be found, that the number of rainy days, as well as the quantity of rain, is far greater on the western than on the eastern side of this line. Abstracting some particular spots also, the quantity of rain diminishes in this latter division as we recede from the sea; while both the mean annual temperature will be found the least, and the severity of winter the greatest, in that middle tract which contains the courses of the Garry and the Spey. The district of Badenoch is in fact the coldest, and, in the Highlands, probably the driest part of Scotland; and the rocky mountains of that division, therefore, seem most particularly adapted to this object.

The necessity of rocky and mountainous pasture is more particularly rendered obvious by that disease of the feet which was mentioned in recording the experiment made at Dunkeld, and, it must here be added, that the growth of the hoofs in one of these animals was checked, and the feet restored to a sound state, merely by allowing it a free access to a paved stable. Although it was mentioned in the preceding remarks, that it had been found necessary to pare the hoofs in India, it does not appear that this practice is required in Thibet, where, doubtless, they have a free range over rocky ground during the summer, or on hard ice in winter. Moisture is indeed injurious, as is well known, even to the feet of sheep; and the common goat of the Highlands invariably avoids the low grounds, when in its power, to seek refuge among the dry and stony places.

A fear lest they should become a prey to the fox, which, in the Highland mountains, is a very powerful and comparatively a bold animal, prevented the risking of those which were at Blair and Dunkeld in the hill pastures, and thus probably tended to their destruction. That caution would not be necessary, should they become more numerous. But although

these goats were extremely gentle and familiar, partly owing to the mode in which they are reared in Thibet, and partly owing to a long sea voyage, they are courageous; and, as the female as well as the male is provided with powerful horns, it is not likely that the fox would attack them, as he never attempts the horned sheep unless they are reduced by disease.

In their native country, the goats are driven in, in the evening, for the purpose of milking the females; and it appears that they are also provided with sheds, in which they may occasionally be sheltered from the rain. Their habits are, in fact, those of a domestic and not of a wild animal; and to this care is probably owing much of their good qualities, and of the various degrees of excellence which are found in the wool in different situations. It would, therefore, be proper for those who may repeat the experiments on their cultivation in this country, to bear these circumstances in mind, and to provide them with that shelter and attention which they seem to require.

With respect to their pasture, it is found, that they not only shun the rich grasses, but that this food is injurious to their health and to their fleeces. In this respect they resemble the common goat of this country, who invariably avoids these pastures, if he can get access to rocky land, covered with a variety of shrubs and plants. In their native hills, they thus travel for great distances among the dry and scanty pasturages; and this free range and exercise is considered to be conducive to their health. They are found to subsist indiscriminately, like their species elsewhere, on all the plants and shrubs within their reach, and chiefly, it is said, on several aromatic plants, and on a prickly shrub which Mr. Moorcroft calls furze. Of this, no botanical description has been given, and it has been supposed, that it cannot be the *Ulex Europæus*. This, however, does not follow, as many of the common European plants are found to inhabit the high mountains of middle Asia, and as it appears that even our common gooseberry plant is found in the mountains in question. In this country, it has been ascertained that they eat the common furze with

avidity; and, like the sheep, they also brouze on the young shoots of the heaths. It is further said that they are particularly fond of rue; and, in India, it is recommended to keep this plant in the enclosures in which they are confined in that country. The whole of the species, indeed, appears attached to all the strong-tasted plants, and even to those poisonous species which other animals refuse; but it is evident that, on a large scale, it would be impossible to pay attention to any cultivation of this nature, while the advantages to be derived from it are probably in a great measure visionary. When the ground is so covered with snow in Thibet that the plants are no longer accessible, they are fed on the bruised tops of the furze above mentioned.

It is found to be a salutary practice to give them salt once in a week; and this is said to be general in their native district, and to be the only particular expense to which the p-oprietors are subject. From this condiment, indeed, all graminivorous animals appear to derive benefit; and, in the commencement, at least, of their naturalization in this country, it ought to be adopted. Had it been known when the first flocks arrived, it might perhaps have prevented their loss.

It is now well known to naturalists, that the goat of Thibet is merely a variety of the common goat; differing from it only in the nature and quantity of its clothing, as that has been modified, partly by the climate which it inhabits, and partly, it is to be presumed, by careful breeding and cultivation. The individuals vary much in size; but are generally all characterized by a head somewhat large when compared to the breeds of our own country, long horns lying backwards and slightly bent, a straight back and delicate limbs.

The coat consists of a thick covering of long coarse hair externally, concealing the fine wool, which is curled up close to the skin. No material differences could be discovered in the wool of those which arrived in Scotland; but it is well known that they vary materially in this respect; and it is further suspected, that although the most weighty fleeces come from the coldest regions, the finest are produced where most care is

bestowed on the animal; as, in the sheep, the wool of yearlings is found to be of the finest quality, and is always distinguished in the market as a superior article. It is also remarked, that the white fleeces are less fine than the coloured, and that the black are the finest of all. They equally vary in quantity; the finest wool also producing the heaviest fleece.

The varieties in respect to colour which arrived in Scotland were white, white and brown intermixed, and black. In their native country it is remarked, that those which inhabit the most elevated valleys are of a bright ochre yellow; that, lower down, they are yellow and white intermixed; and that, still further from the highest tracts, they are pure white, or white stained with black or brown. It is not mentioned whether the black variety is limited to any particular district, but, from the much superior price of its produce, it is probably rare.

In Tartary, the fleeces are shorn with a knife, in a rude manner, about the end of Spring, when the snows have melted; and it is probable that our own period of sheep-shearing would be the proper time for that operation in this country. It was formerly remarked, that the first flock at Blair was shedding the fleeces in August. Those at Dunkeld had entirely lost theirs at the end of July. In August, the flock in Sutherland was also losing the fleeces.

The last circumstance, which now remains to be mentioned respecting the shawl goat, is the treatment of the fleeces.

In Tartary, they first undergo two sortings: one according to their colour, and another according to their quality. With respect to the latter operation, two degrees of fineness only are distinguished. It is probable, that from the rude mode of shearing adopted, the whole fleece is confounded together; and, that the separation of the different qualities is far less perfect than it would be in this country, if the fleece was shorn entire, and then separated, as is done in the sheep. After shearing, the long hairs are all picked by hand from the wool, an operation which is understood to be performed by children, but which must be both tedious and expensive. It is probable, that if ever the animal should be naturalized in this country, some

sort of machinery would be applied to diminish this labour, as the hair is not entangled in the wool. In those fleeces which were naturally shed in Scotland, the wool was almost entirely separated from the hair during that act; so that from one goat, I procured nearly a clean fleece in this manner.

After the several operations of picking and sorting, according to the degrees of fineness and colour, the wool is washed in a warm and weak solution of potash, and afterwards in water. It is then bleached on the grass, and, when completed, is carded, and prepared for spinning.

That wool which is intended for dyeing, is dyed once before carding: it is then dyed a second time after spinning, and once more when manufactured into the shawl. Great attention is required in the washing to prevent it from felting.

The spinning in Tartary is all performed by hand with the distaff and spindle; the latter being made of a ball of clay, containing an iron wire, and the finger and thumb being preserved in a smooth state by powdered steatite. Great care is taken not to spin the thread too hard, as the softness of the future shawl depends much on its texture in this respect.

The weight of wool required for a superfine shawl is five pounds, for one of the second quality three, and for the inferior sort two.

I may conclude this subject by mentioning the attempts which have been made to imitate this manufacture in our own country.

Some bales of shawl wool were imported by the East India Company a few years ago; but it was found, on trial, that the Norwich manufacturers could not spin it so as to produce a thread of equal fineness and goodness with that from Merino lamb's wool, although the staple is at least five times as long. It had, therefore, very little sale, as it was only occasionally used to work up with other wools. But a simple method of spinning it by machinery was discovered two years ago by Mr. Main, of Bow Lane, in Cheapside; and, by that, threads have been produced even much finer than is necessary, and indeed superior in texture to the best of Thibet

manufacture. It is, therefore, not impossible, that we shall hereafter be in possession, not only of the material, but of the means of manufacturing from it an article of great value, for which the demand has hitherto been limited only by the scantiness of the supply.

I am, Sir, your's, &c.

J. MACCULLOCH.

Art. XII. *Proceedings of the Royal Society.*

The following papers have been read at the Table of the Royal Society, since our last report.

March 23.—On the means of supplying muscles in a state of spasm or paralysis with nervous power, by Mr. J. Hood, communicated by the President.

April 13.—On the milk, tusks, and organs of hearing of the dugong, by Sir Everard Home, Bart., V.P.R.S.

April 20.—On the improvement in the eye-tubes of portable achromatic telescopes, by William Kitchiner, M.D.

On the different qualities of the alburnum of spring and winter-felled oak-trees, by Thomas Andrew Knight, Esq.

April 27.—On the properties of domes and their abutment walls, by Samuel Ware, Esq.

May 4.—On diarrhæa asthenica, by Assistant-Surgeon Hood.

On the mode of formation of the canal for containing the spinal marrow, and on the form of the fins of the proteosaurus, by Sir Everard Home, Bart, V.P.R.S.

May 11.—Some experiments on the fungi which constitute the colouring matter of the red snow discovered in Baffin's Bay, by Francis Bauer, Esq.

May 18.—Some account of the dugong, by Governor Sir T. S. Raffles.

Art XIII. ASTRONOMICAL AND NAUTICAL COLLECTIONS, No. II.

i. *Report of the* Committee of the Board of Longitude, *for examining Instruments and Proposals, upon the Mode employed for determining the Errors of dividing Engines.*

[Published by permission of the Board.]

1. Two double circles of brass were prepared, each consisting of two concentric circles moving on the same axis, and supported by radii, so as to have their upper faces in the same plane, the one turning in perfect contact with the other; they were eighteen inches in diameter at the common circle of contact.

2. One of these double circles was fixed on each of the engines to be compared, and divided into degrees, by lines drawn across the circle of contact; care being taken to prevent the cutting tools entering too deep, where the division of the circles interrupted the lines.

3. The divisions being completed, and the degrees numbered, the circles were fixed on an axis, attached to a small board or table, in order for examination by means of a micrometer in the possession of Captain Kater.

4. The zero of the inner circle was moved so as to correspond with a division of the outer circle at the distance of some aliquot part of the circumference from 0, and there fixed by a clamp, while the imperfections of the coincidences of all the other points, at the same distances from each other, were separately examined by means of the micrometer.

5. It was then inferred, that since each point of the inner circle must have moved through a space equal to the first aliquot part of the outer, the intervals or errors measured must be the differences of each arc of the outer circle from the first; and since the sum of all the arcs is always exactly 360°, the result of all the errors of the arcs additive and subtractive must be 0, and the sum of the differences divided by the whole number of aliquot parts, must give the error of the first arc, which being deducted from the several differences measured, gives the errors of the respective *arcs;* and the sums of the successive errors of the arcs give the true errors for *each point.*

6. It was thought sufficient to carry this examination as far as $\frac{1}{9}$, making the series 2, 3, 4, 5, 6, 8, 9, which determines 22 points, at the distances 0°, 40°, 45°, 60°, 72°, 80°, 90°, 120°, 135°, 144°, 160°, 180°, and their supplements; many of these points being ascertained by several different measurements.

7. Where the errors were observed to increase in approaching to a particular division, it was inferred that they were partly owing to a defect in the centring of the instrument; and an allowance was made, in proportion to the cosine of the interval from the apparent maximum, to such an amount as would give the most favourable result.

8. It had hitherto been supposed that the zero was free from error in relation to the mean of the other divisions; but if it appeared that after the correction for the central error, the particular errors remained mostly positive or mostly negative, a quantity was deducted as a common error, such as to render the positive and negative errors nearly equal; and this error was considered as that of the zero itself.

9. *Specimen of the Examination.*

Allan's third Division.

Displacement 40°.				Displacement 60°.			
At	Difference.	Error of arc.	Error of point.	At	Difference.	Error of arc.	Error of point.
0°	0″	″	0″	0°	0″	″	0″
40	0	−11	−11	60	0	−6⅓	−6⅓
80	+16	+ 5	− 6	120	+12	+5⅔	− ⅔
120	+16	+ 5	− 1	180	+12	+5⅔	+5
160	+11	0	− 1	240	+ 7	+ ⅔	+5⅔
200	+21	+10	+ 9	300	+ 5	−1⅓	+4⅓
240	+ 9	− 2	+ 7	360	+ 2	−4⅓	0
280	+17	+ 6	+13		6)38		
320	+ 1	−10	+ 3		6⅓		
360	+ 8	− 3	0				
	9)99						
	11						

10. *General Results for the same Division.*

At	Errors observed.	Mean.	Angles from 0° or 180°.	Correction as sine.	Remaining error.	Add −½
40°	−11″	11″	40°	+4″	−7″	−7½
45	−12	−12	45	+4	−8	−8½
60	− 6⅓	− 6	60	+5	−1	−1½
72	− 9	− 9	72	+6	−3	−3½
80	− 6	− 6	80	+6	0	− ½
90	− 5½, −1½	− 4	90	+6	+2	+1½
120	− 1, −⅔, +1⅓	0	60	+5	+5	+4½
135	− 2¾	− 3	45	+4	+1	+ ½
144	0	0	36	+3	+3	+2½
160	− 1	− 1	20	+2	+1	+ ½
180	+ 3, +5, +2, +2½	+ 3	0	0	+3	+2½
200	+ 9	+ 9	20	−2	+7	+6½
216	+ 7	+ 7	36	−3	+4	+3½
225	+ 5¾	+ 6	45	−4	+2	+1½
240	+ 7+5⅔+3⅓	+ 5	60	−5	0	− ½
270	+ 4½, +4½	+ 5	90	−6	−1	−1½
280	+13	+13	80	−6	+7	+6½
288	+ 9	+ 9	72	−6	+3	+2½
300	+ 4⅓	+ 4	60	−5	−1	−1½
315	+ 2¼	+ 2	45	−4	−2	−2½
320	+ 3	+ 3	40	−4	−1	−1½
360					22)14	22)62
					½	2″,8

Hence the mean error of these divisions appears to be nearly 3″, the greatest about 7″.

ii. *A comparative View of the Principal Methods of correcting Lunar Observations, with a new Construction.*

The practical eligibility of the different methods of correcting lunar observations must depend, in great measure, on the means which may be in the computer's possession; and it will be convenient to consider, first, the methods which may be employed with the simplest means, and to proceed afterwards to those which are more refined in their details, and which are calculated to comprehend the minuter quantities concerned in the results.

I. *Without either Tables or Instruments.*

The son of an illustrious statesman, now a young midshipman, is said to have astonished his shipmates, by working out the correction of a lunar observation, unassisted by books or instruments of any kind. It is right that so brilliant an exhibition of mathematical talent should be recorded with some degree of authenticity, as well for the honour of the individual, as for the credit of the Naval Academy at Portsmouth, through which this Nelson or Newton in embryo has passed, without favour, in less than half the regular time. But it is not to be expected that such a method of correction will become very universal, even in the British navy, and we must therefore be contented to examine some of the processes adapted to humbler capacities.

II. *By the line of Chords.*

1. Draw a circle, and a radius for the *lunar line*, equal to the chord of 60°.

2. At an angular distance equal to the observed distance, draw another radius for the *solar line*.

3. Set off the zenith distances on each side of the respective radii, and draw the chords of the double arcs.

4. Measure the distance of the intersection of the chords from the lunar radius, on the line of chords, for the *correction*, which will be subtractive when the intersection is on the same side of the lunar radius with the solar radius, and additive when on the opposite side.

5. In order to reduce the correction, multiply it by the horizontal parallax, and divide it by 62° when it is subtractive, and by 53° when additive, and apply the *reduced correction* to the observed distance.

This method is published in Dr. Kelly's Spherics; it is very expeditious, and its result is generally within about a minute of the truth, corresponding to half a degree of longitude, and often still nearer. But the construction may be rendered much more accurate by the assistance of the sector and a scale of equal parts.

III. *By the Scale and Sector.*

1. With a radius equal to the horizontal parallax, taken from any scale of equal parts, draw a circle, and a line for the *lunar radius.*

2. At an angular distance equal to the observed distance, draw another radius for the *solar line.*

3. Set off the zenith distances on each side of the respective radii, and draw the chords of the double arcs.

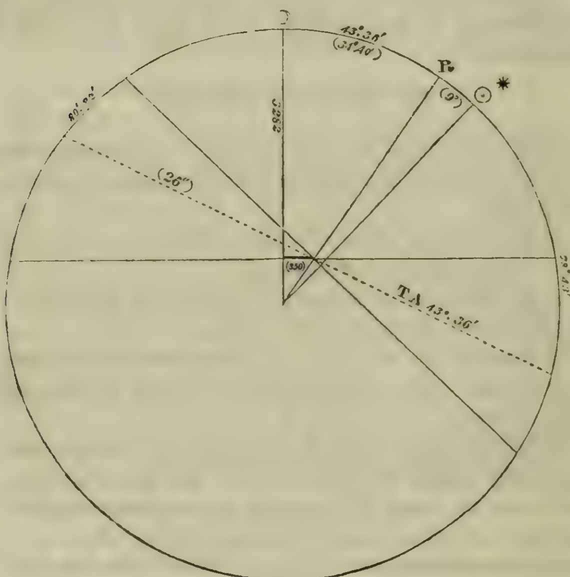
4. Measure the distance of the intersection of the chords from the lunar radius, on the scale of equal parts, for the *parallactic correction.*

5. Draw a radius through the intersection of the chords, measure its angular distances from the two former radii; and take, from the table of refractions, the refractions answering to these two angles as zenith distances, for the effects of the *respective refractions.*

6. When the observed distance is small, take its tangent with respect to the given circle, from the sector, or otherwise; apply this tangent within the circle, from the intersection of the two chords, so as to make one of the segments of a new chord, and measure the other segment of this chord by means of the sector, setting the radius of the circle to the horizontal parallax in minutes, diminished by 28′, on the line of lines; the result will be the correction for obliquity in seconds. If the tangent is too short to reach the circle, take its double or quadruple, and double or quadruple the number found accordingly.

7. Apply the four corrections thus found to the apparen distance, subtracting the parallactic correction, and adding the refractions, when the intersection of the chords is on the same side of the radius concerned with the other radius, and the reverse when on the opposite side; and adding the correction for obliquity, when the distance is less than 90°.

EXAMPLE.



The diagram here exhibited was constructed, of the same size, from an example in the Requisite Tables, with a common ivory half inch diagonal scale, and a six inch sector only. The observed distance ☽ ☉ is 43° 36′, the moon's altitude 9° 38′, Z. D. 80° 22′; the sun's or stars 11° 17′, Z. D. 78° 43′; and the moon's horizontal parallax 54′ 42″=3282″. Hence we obtain the parallactic correction 350″, the refractional distances ☽ R and ☉ R about 34° 40′ and 9°, giving for the corrections 40″ and 9″; and, measuring the segment of the chord, found

from the tangent, on the sector, with the radius set to 55 — 28 =27, we have 27″ for the effect of obliquity. The sum of the last three corrections is 76″, which, subtracted from 350″, leaves 274″=4′ 34″, to be subtracted from the observed distance. The true correction is 4′ 41″, differing only 7″ from this approximation. The distance of the intersection, measured by Dr. Kelly's method, is about 6°, making the reduced correction 317″=5¼′, which is too great by half a minute only.

IV. *By common Logarithmic Tables.*

A. If we have only common tables of logarithms at hand, we shall find the approximate methods of computation considerably more expeditious than the direct, and sufficiently accurate for all common purposes. It will be found one of the easiest approximations to follow the steps of the constructor by the scale and sector, and the precepts will stand thus:

1. To the logarithmic sine of the sun's altitude, add the cosecant of the distance, and find the number corresponding.

2. To the logarithmic sine of the moon's altitude, add the cotangent of the distance, and subtract the natural number corresponding from the former number; or, where the observed distance exceeds 90°, take the sum instead of the difference.

3. Subtract the logarithm of the difference or sum from the proportional logarithm of the horizontal parallax, and the remainder will be the proportional logarithm of the *parallactic correction.*

4. From the same logarithm of the difference or sum, subtract the sine of the moon's altitude; the difference will be the tangent of the lunar refractional distance, which, subtracted from the observed distance, will give the solar refractional distance. Find the refractions answering to these zenith distances for the *refractional corrections.*

5. Take the sum and difference of the same difference or sum and the numerical cosine of the moon's altitude; add together their logarithms, the cotangent of the observed distance and the constant logarithm 8.4130, and the sum, subtracted

from twice the proportional logarithm of the horizontal parallax will give the proportional logarithm of the correction for obliquity.

Note. If a table of proportional logarithms is not at hand, we may take the common logarithm of the horizontal parallax in seconds, and find from it the logarithm of the parallactic correction by adding the logarithm of the difference (3) instead of subtracting; and in the fifth precept, add all the logarithms together, employing 6.2370 for a constant factor, instead of 8.413.

Example I.

Taking the case already constructed for an example, the moon's proportional logarithm being 5173, the operation will stand thus:

1.	Log. sine *	11° 17′	9.2915
	Cosec.	43 36	10.1614
	N.	.2837	9.4529
2.	Log. sine ☽	9° 38′	9.2236
	Cot.	43 36	10.0212
	N.	.1757	9.2448
3.	Log. diff.	.1080	9.0334
	Prop. log.		.5173
	Prop. log.	5′ 54″	1.4839

4.	Log. diff.		9.0334
	Sine ☽		9.2236
	Ta.	32° 59′	9.8098
		43 36	
	R. D. *	10 46	

5.	Nat. cos. ☽	.9859	
	Dist.	.1086	
	Sum	1.0945	.0393
	Diff.	.8773	9.9431
	Log. cot. dist.		10.0212
	Const. log.		8.4130
	Sum		8.4166
	ouble P. L.		1.0346
	P. L. 26″		2.6180
	Par. corr.	5′ 54″	
	Deduct } 37″		
	Refr. } 10		
	Obliq. 26	1 13	
	Final correction	4 41	

Their correction, thus determined, agrees exactly with the correct computation; so that the error of the diagram depended wholly on the inaccuracy of the operation, or of the instruments employed.

Example II.

Let the distance be 103° 29½′, the moon's altitude 41° 6′, the sun's 19° 4′, the horizontal parallax 58′ 35″. P. L. 48‾5.

1.	Log. sine ☉	19° 4′	9.5141
	Cosec.	103 29½	10.0121
	N. +	.3359	9.5262
2.	Log. sine ☽	41° 6′	9.8178
	(—) cota.	103 29½	9.3890
	N. —	.1577	9.1978
3.	Log. diff. +	.4936	9.6934
	P. L.		.4875
	P. L.	28′ 55″	.7941
4.	Log. diff.		9.6934
	Sine ☽		9.8178
	Ta.	36° 54′	9.8756
		103 29	
	☉ R. D.	66 35	

5. Nat. cos. ☽		.7536	
Diff. (3)		.4936	
Sum		1.2472	.0959
Diff.		.2600	9.4150
L. cota. dist.			9.3800
Const. log.			8.4130
			7.3039
Double P. L.			.9750
P. L. 2″			3.6711
Par. corr.		28′ 55″	
Deduct	43″		
	2′ 11		
Add		2″	
		28′ 57″	
		2 54	
Final correction		26 3	

Dr. Brinkley makes the correction in this example 26′ 6″, Dr. Maskelyne 26′ 9″.

Demonstration.

This computation is an exact counterpart of the construction, as will appear from a consideration of the figure, supposing a diameter to be drawn parallel to the lunar chord, on which the sum or difference (2) will be projected. The same demonstration will consequently serve for both methods.

Since in every spherical triangle (ABC), cos. a = cos. b cos. c + sin. b sin. c cos. A, if we call the angle at the moon A and consequently the zenith distance of the sun or star a, that of the moon b, and the distance observed c; since the effect of the horizontal parallax p is first reduced by the altitude to p sin. b, and then by the obliquity to p sin. b cos. A, we have for the multiplier of the horizontal parallax sin. b cos. A $= \frac{\cos. a}{\sin. c} -$ $\frac{\cos. b \cos. c}{\sin. c} = \cos. a. \text{cosec. } c - \cos. b \cot. c$ (1,2,3).

In the next place the direct effect of refraction is to be

reduced for the moon in the same ratio of cos. A, the primitive refraction being very nearly expressed by q tang. $b = q \frac{\text{sin. } b}{\text{cos. } b}$, so that the correction may be called q cos. A $\frac{\text{sin. } b}{\text{cos. } b}$, and if we find the angle E, such that $\frac{\text{cos. A sin. } b}{\text{cos. } b} =$ tang. E, the correction becomes q tang. E, which is the refraction appropriate to the zenith distance E, being always somewhat more correct than taking the refraction simply proportional to the tangent, and of course abundantly accurate for the present purpose. It is also obvious, from an inspection of the figure, that the distance of the same radius from the solar line will determine the effect of solar refraction in the same manner.

The correction for the obliquity of the true distance, compared with the apparent, is found in the same manner as in the Preface to Dr. Maskelyne's *British Mariner's Guide*. Since the cosine of the hypotenuse of a triangle h is equal to the rectangle of the cosines of the legs d and k, we have cos. $h =$ cos. d cos. k, or since k is very small, and cos. $k = 1 - \frac{1}{2} k^2$, cos. d $-$ cos. $h = \frac{1}{2} k^2$ cos. d; and the small differences of cosines, divided by the sine, being as the differences of the arcs, $h - d$ $= \frac{1}{2} k^2 \frac{\text{cos. } d}{\text{sin. } d} = \frac{\frac{1}{2} k^2}{\text{ta. } d}$. Now $k = p$ sin. b sin. A, and $k^2 = p^2$ sin.$^2 b$ (1 $-$ cos. ^{2}A) $= p^2$ (sin. b + sin. b cos. A) (sin. b $-$ sin. b cos. A), whence the construction is easily derived.

The process requires, in this form, only 12 references to tables of four places, besides the refractions, which are taken out with the same ease as the direct refractions in the ordinary methods of computation.

B. A similar computation may, however, be performed by 11 references to tables only, besides the refractions, and without having occasion for a table of natural sines.

1. Call the observed distance d, the altitudes m and s, and the half sum of these three angles k.

2. To the proportional logarithm of the horizontal parallax, add the logarithmic secant of the moon's altitude m, the sum will be the proportional logarithm of the parallax in altitude.

3. Add together the logarithmic secant of h, the sine of d, the cosecant of $h - s$, the constant logarithm 9.6990, and the proportional logarithm of the horizontal parallax: the sum will be the proportional logarithm of the diminution of parallax, which is to be subtracted from the parallax in altitude, in order to obtain the *parallactic correction.*

4. To the logarithmic sine of the moon's altitude m, add the proportional logarithm of the parallactic correction, and subtract the sum from that of the horizontal parallax, the difference will be the tangent of the refractional distance for the moon. Find the *refractional correction* for this angle, and for its difference from the observed distance, as zenith distances, in the table of refractions.

5. When the distance d is small, add together the proportional logarithms of the diminution of parallax, and of the sum of the parallactic correction (3) and the parallax in altitude (2), the logarithmic tangent of d, and the constant logarithm .5870: the sum will be the proportional logarithm of the correction for obliquity.

EXAMPLE.

1. Taking d again $= 43° 36'$, $m = 9° 38'$, $s = 11° 17'$, $p = 54' 42''$, and its P. L. 5173, we have $h = 32° 15\frac{1}{2}'$, $h - s = 20° 58\frac{1}{2}'$, and $h - m = 22° 37\frac{1}{2}'$.

2.	P. L. p =	.5173	4.	Log. sin. m	9.2236
	Log. sec. m	.0612		P. L. 5′ 54″	1.4844
	P. L. 53′ 55″	.5785		Sum	.7080
				P. L. p	.5173
3.	Log. sec. h.	.0728		Log. ta. 32° 48′	9.8093
	sin. d.	9.8386			
	co-sec. $h-s$	.4462	5.	P. L. Dim. p	.5739
	$\frac{1}{2}$	9.6990		P. L. 59′ 49″	.4784
	P. L. p.	.5173		Log. tang. d	9.9788
	P. L. 48′ 1″	.5739		Const. log.	1.5870
	Diff. 5 54			P. L. 26″	2.6181
	Sum 59 49				

But 5′ 54″ − (37″ + 10″ + 26″) = 4′ 41′, as before.

C. Dr. Maskelyne's method, explained in the Requisite Tables, is considerably more complicated than this, and appears to possess no particular advantage in any case.

D. Mr. Lyons's method is shorter than Dr. Maskelyne's, but requires about seventeen references to tables, including two peculiar tables occupying about four pages, which are printed in the Requisite Tables and elsewhere, and which afford, by a double entry, the correction for the obliquity. (A. Precept 5.)

E. Mr. Witchell's method requires 25 references to tables, including the determination of the correction for obliquity; and neither of these three methods is materially more accurate than the rule here laid down with 11 or 12 references only.

IV. *By the Requisite Tables.*

The methods of Dr. Maskelyne and of Mr. Lyons comprehend the employment of some short tables, which are printed in this work, as well as the method of Mr. Dunthorne, which is more perfect, but in which the logarithms must be taken out to seconds.

V. *By the Requisite Tables with the Appendix.*

The Appendix to the Requisite Tables contains a very well-contrived table for obtaining the natural verse sines to seconds, which is rendered much more concise than a logarithmic table could possibly be. By means of this table, together with Mr. Dunthorne's very useful invention of logarithmic differences, which form a table, showing the logarithm of the product of the cosines of the corrected altitudes, divided by that of the cosines of the apparent altitudes, the correct computation may be performed more readily, than by any other method, depending on these collections of tables alone.

Mr. Dunthorne's table is also found, in an improved form, with the addition of differences, in the *Connaissance des Tems* for 1788, and in *Norie's Navigation.*

A. Example from the Appendix.

Given the distance $d = 59° \ 25' \ 34''$, the moon's altitude $m = 27° \ 2' \ 30''$, the sun's $s = 59° \ 11' \ 52''$, and the horizontal

parallax $p = 59' \ 27''$; whence we find the tabular corrections of the altitudes $+ 51' \ 33''$, and $- 30''$, the difference of the apparent altitudes $32° \ 9' \ 22''$, the difference of the true altitudes $31° \ 17' \ 19''$, and the tabular logarithmic difference $9.996735 - .. 16 = 9.996719$. The computation will stand thus:

Verse sine $m \sim s$	153399		
d	491351		
Difference	337952	Log.	5.528855
		+ L. D.	9.996719
Number	335407	Log.	5.525574
Verse sine diff. tr. alt. +	145437		
Verse sine true distance	480844		58° 43′ 28″

We have here only about nine references to tables, four of them relating to verse sines with seconds; and the result is free from all error and ambiguity.

B. *Mendoza's Method at length.*

Mr. Mendoza finds an angle b, of which the logarithmic cosine is equal to the logarithmic difference lessened by the logarithm of 2, which, in the last example, becomes 9.695689, whence $b = 60° \ 14' \ 55''$: he then takes the sums and differences $m + s + b$, $m + s - b$, $d + b$, and $d - b$, and adds their verse sines to that of the supplement of the sum of the true altitudes. The operation will stand thus, observing that the verse sines of arcs above 90° may be easily found from a table of sines.

Verse sine	146°	29′	1.833725	+ 17″	45
	25	59	101078	27	57
	119	40	1.494953	29	122
		49	000102	21	1
	92	54	1.050593	35	169
			394		
V. s.	58° 43′ 28″		(4).480845		

This process has three more references to tables with seconds than the last, and has therefore no advantage in its independent form; but *Mr. Mendoza's* great *Tables* give at once the angle b,

instead of the logarithmic difference; and by entering another table with this angle, and first with the distance, and secondly with the sum of the apparent altitudes, he takes out at once the sums of the respective pairs of verse sines, so that he requires, after the auxiliary angle is found, only four references to tables, though two of them involve double entries.

VI. *By Dr. Brinkley's Tables.* Naut. Alm. 1820, 1821.

Dr. Brinkley has published two new methods of computing the corrections of Lunar distances in a compendious manner. The principal peculiarity of the first method is to obtain, from some very short tables, an equivalent to Dunthorne's logarithmic difference, the rest of the computation resembling that of the Appendix to the Requisite Tables. The second method is a very good approximation, not requiring the natural verse sines; in which, however, there are about 20 references to short tables of a few figures, so that the whole process does not appear quite so compendious as that which has been explained in Section IV., though it may be a little more accurate in some extreme cases, and may therefore be occasionally employed with advantage in the absence of tables carried to seconds, if Dr. Brinkley's happen to be at hand.

VII. *By Logarithms carried to Seconds.*

The methods of Borda, published in the *Connaissance des Tems* for 1775, and elsewhere, seem to be the most convenient of the direct methods, when we have logarithms of sines carried to seconds: they are somewhat shorter than Dunthorne's, but they may be rendered still more compendious by employing Dunthorne's table.

Example.

Supposing still $d = 59° 25' 34''$, $m = 27° 2' 30''$, $s = 59° 11' 52''$, $p = 59' 27''$, the corrections of the altitudes $+ 51' 33''$ and $- 30''$, and Dunthorne's difference 9.996719, we find $\frac{1}{2}(m + s + d) = h = 72° 49' 58''$, $h \sim d = 13° 24' 24''$, and the half sum of the corrected altitudes $43° 32' 42\frac{1}{2}''$: or,

secondly, $h - m = 45° 47' 28''$, $h - s$ $13° 38' 6''$, and the half difference of the true altitudes $15° 38' 39\frac{1}{2}''$: and the immediate operations will stand thus:

Rossel's Method, C. T.

Log. Diff. - - - - - - -		9.996719
Cos. h - - - - - -		9.470060
Cos. $h \sim d$ - - - -		9.988001
	2) [1]	9.454780
		9.727390
— Cos. ½ sum - - - -		9.860237
Sine - - - - -		9.867153
Corresp. cos. - - -		9.830251
+ Cos. ½ sum - - - -		9.860237
Sine	29° 21′ 44″	9.690488
Double	58 43 28	the true distance.

Adams's Method modified.

Log. Diff. - - - - - - -		9.996719
Sin. $h - m$ - - - -		9.855400
Sin. $h - s$ - - - - -		9.372426
2 Log. sec. ½ diff. - - -		20.032788
	2) [1]	9.257333
Sine - - - - - - -		9.628666
Corresp. cos. - - -		9.956680
Cos. ½ diff. - - - -		9.983606
Cos. 29° 21′ 44″ - -		9.940286

The second process has been lately re-invented by Mr. Adams of Stonehouse; it may, however, be found in the *Berlin Almanac* for 1785, where it is attributed to Borda.

Dunthorne's own Method.

Log. Diff.	9.996719	Half diff. tr. a.	15° 38′ 39½″
Sin. $h - m$	9.855400	Angle found	24 10 28
Sin. $h - s$	9.372426	Difference	8 31 48½
	2)[1] 9.224545	Sum	39 49 7½
Sin. 24° 10′ 28″	9.612272		
Log. cos. diff. found	9.995169		
+ Sum	9.885403		
	2)19.880572		
Cos. 29° 21′ 44″	9.940286, half the true distance.		

In Borda's processes there are five references to the table of logarithms, instead of the four references to the tables of verse sines, and two to that of logarithms, employed in Section VI.; and the advantage of simplicity seems to turn the scale in favour of Borda's method, when tables of logarithms to seconds are at hand. In Dunthorne's own method there are six references to tables, and some further addition and subtraction.

IX. *By Mendoza's Tables.*

See Section VI. The only objection to Mendoza's very ingenious arrangement seems to be the double entry that is required at the principal steps, and perhaps the bulk of the volume of tables. Indeed the whole process is so much altered from the original steps of the demonstration, that it must be considered as an operation equally mechanical with the motion of a machine, or the reference to a single table of corrections, which is the next method to be considered.

X. *By Shepherd's Tables.*

The great Tables of Corrections, published, at no small expense, by the Board of Longitude, have been so little in request, that the greater part of the impression is said to have been condemned to be sold for waste paper. It is true that the labour required for taking out all the corrections and their differences,

and for properly combining them, will generally be somewhat greater than that of the entire computation by the shortest of the methods already enumerated; and this objection, together with the unwieldly bulk of the volume, will probably be sufficient to prevent these tables from ever acquiring any great degree of popularity.

EXAMPLE.

Taking, as in the last example, $d = 59° 25' 34''$; $m = 27°$ $2' 30''$, $s = 59° 11' 52''$, and $p = 59' 27''$, we have to proceed thus:

d 59°, *m* 27, *s* 59	Red. — 36′ 58″	Log. — 140				
d 59, *m* 27, *s* 60	— 37 30	— 134				
d 59, *m* 28, *s* 59	— 36 31	— 146				
d 60, *m* 27, *s* 59	— 36 37	— 140				
Diff. for 1° *d*	— 1″	0	For 25′ 34″	0	0	
m	— 27	+ 6	2 30	— 1	0	
s	+ 32	— 6	11 52	+ 6	— 1	
				+ 5	— 1	
				36 58	140	
				37 3	— 141	
App. dist.	59° 25′ 34″					
Corr.	41 42			4 39	+ 145	Par. Log. 6′ 27″
	58 43 52		Corr.	41 42	— 286	Par. Log. 4 39

If there is no mistake in this computation, the example is not very likely to rescue the remaining copies of the tables from their impending fate: for an error of 24″ could scarcely have been expected in the coarsest approximation.

XI. *Scales of Reduction.*

Some ingenious attempts have been made to reduce Dr. Shepherd's tables to the form of scales, partaking more or less of the

nature of a graphical construction. But these scales must obviously be liable to the errors which seem to be inherent in the tables; and their application can scarcely be more simple or commodious, than the method by the scale and sector already explained.

XII. *Various Formulas.*

Many other devices have been suggested for facilitating the solution of this important problem; and some of them, though they do not possess equal advantages with those which have been already explained, may deserve to be simply enumerated here.

A. Mr. Krafft's formula, which seems to have been the foundation of Mendoza's, is $\text{vs}\,D = \text{vs}\,(d + b) + \text{vs}\,(d \sim b) - \text{vs}\,([m \sim s] + b) - \text{vs}\,([m \sim s] \sim b) + \text{vs}\,(M + S)$, D, M, and S being the true distance and the true altitudes, and b the auxiliary angle, of which the cosine is $= \frac{1}{2}$ cos. M cos. S sec. m sec. s.

B. Dr. Maskelyne's formula, published in the Introduction to *Taylor's Logarithms*, is equivalent to this; tang. $b =$ cosec. $\frac{1}{2}$ $(M \sim S) \surd$ (sin. $\frac{1}{2}$ $(d + [m \sim s]$ sin. $\frac{1}{2}$ $(d - [m \sim s])$ cos. M cos. S sec. m sec. s); and then sin. $\frac{1}{2}$ D $=$ sin. $\frac{1}{2}$ $(M \sim S)$ sec. b.

C. Several other methods of computation may be found in the *Connaissance des Tems* for 1775, 1785, 1796, 1806, 1807 and 1808. But it is of more importance to attend to such corrections, as are equally applicable to all modes of computation, and without which complete accuracy can never be attained even in ordinary cases.

XIII. *Tables of Minute Corrections.*

Whatever method may be preferred for the accurate calculation of the correction of the distance, there are some precautions, not universally understood, which will require attention when great precision is required.

A. *Of the Vertical Semidiameters.*

Since the actual refraction affects the observation in its primitive state only, it is obvious that the correction, which it requires, must depend on the altitude of the observed limb of

the luminary, and not of its centre. But, in fact, we want for the computation the apparent altitude of the centre, and not of the limb; it is therefore best to find, in the first instance, the apparent altitude of the centre, by applying the vertical semidiameter of the sun or moon, reduced to its apparent magnitude, by subtracting from the semidiameter found in the ephemeris the correction given in the following table :

Altitude	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	18°	20°	30°	45°
Correction	25″	19″	14″	11″	9″	8″	7″	6″	5″	4″	4″	3″	3″	2″	1″	1″

After applying the semidiameter with this correction, as well as that augmentation, for the moon, which depends simply on the sine of the altitude (R. T. IV.) the refraction and parallax may be taken out for the centre of the luminary. Strictly speaking, the refraction ought to be subtracted first, and the parallax then found for the diminished altitude: but the difference, arising from the neglect of this precaution, seldom amounts to a second, and there is no material objection to the practice of taking out both these corrections from the same table.

B. *Of the Horizontal Parallax.*

We must not, however, forget to enter the table of the lunar corrections with the tabular horizontal parallax of the ephemeris, properly reduced for the latitude, on account of the spheroidal figure of the earth; since the parallax, as set down in the tables, is calculated for the equatorial radius of the earth, and requires to be diminished by a correction which varies as the square of the sine of the latitude, or as the verse sine of twice the latitude. This correction is computed in the annexed table, the ellipticity being supposed $\frac{1}{300}$; and it may be taken out simply for the nearest latitude: thus, for Greenwich, it will be 6″ for 53′ H.P., and 7″ for 55′, or more.

DIMINUTION OF THE HORIZONTAL PARALLAX.

Subtract	Equatorial. 53′	55′	57′	Parallax. 59′	61′	Subtract
1″	Lat. 18°	18°	17°	17°	17°	1″
2	26	25	25	24	24	2
3	32	31	31	30	30	3
4	38	37	36	36	35	4
5	43	42	41	41	40	5
6	49	48	47	46	45	6
7	55	54	52	51	50	7
8	61	59	58	56	55	8
9	69	66	66	62	60	9
10	79	74	71	68	66	10
11	*	*	83	71	74	11
12	*	*	*	*	88	12

Otherwise, for the Proportional Logarithm,

Lat.	0°	11°	19°	25°	30°	34°	39°	43°	47°	51°	56°	60°	61°	71°	79°	90°
Add	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	

C. *Of the Oblique Semidiameter.*

The observed distance requires also to be corrected, when the altitudes are small, for the effect of refraction on the oblique semidiameters, which may amount to several seconds, especially in low latitudes, where the ecliptic approaches most frequently to a vertical position. The magnitude of this correction depends on the angle of the triangle concerned at the luminary in question, which is required to be known when we employ the tables of this correction which have been published. It will, however, be more convenient to have an easy method of deducing the correction more immediately from the elements observed; and for this purpose the minutes and seconds may be neglected, the nearest degrees only being employed for entering the annexed tables. The first table affords, by adding these numbers contained in it, a logarithm of the sine of half the angle at the luminary, multiplied by the cosine of the altitude, and the second table being entered with this argument and with the altitude, gives the proper correction for the oblique semidiameter.

The arguments of the first table are *d* the distance or its sup-

plement, h the half sum of the distance and both altitudes, and $h - s$ the same half sum diminished by the altitude of the *opposite* luminary.

Correction of the Oblique Semidiameter.

TABLE I. For Argument A.

For h °	A	$h-s$ d °	A	For h °	A	$h-s$ d °	A	For h °	A	$h-s$ d °	A
89	924	1	176	59	71	31	29	29	94	61	6
88	954	2	146	58	72	32	28	28	95	62	5
87	972	3	128	57	74	33	26	27	95	63	5
86	984	4	116	56	75	34	25	26	95	64	5
85	994	5	106	55	76	35	24	25	96	65	4
84	2	6	98	54	77	36	23	24	96	66	4
83	9	7	91	53	78	37	22	23	96	67	4
82	14	8	86	52	79	38	21	22	97	68	3
81	19	9	81	51	80	39	20	21	97	69	3
80	24	10	76	50	81	40	19	20	97	70	3
79	28	11	72	49	82	41	18	19	98	71	2
78	32	12	68	48	83	42	17	18	98	72	2
77	35	13	65	47	83	43	17	17	98	73	2
76	38	14	62	46	84	44	16	16	98	74	2
75	41	15	59	45	85	45	15	15	98	75	2
74	44	16	56	44	86	46	14	14	99	76	1
73	47	17	53	43	86	47	14	13	99	77	1
72	49	18	51	42	87	48	13	12	99	78	1
71	51	19	49	41	88	49	12	11	99	79	1
70	53	20	47	40	88	50	12	10	99	80	1
69	55	21	45	39	89	51	11	9	99	81	1
68	57	22	43	38	90	52	10	8	100	82	0
67	59	23	41	37	90	53	10	7	100	83	0
66	61	24	39	36	91	54	9	6	100	84	0
65	63	25	37	35	91	55	9	5	100	85	0
64	64	26	36	34	92	56	8	4	100	86	0
63	66	27	34	33	92	57	7	3	100	87	0
62	67	28	33	32	93	58	7	2	100	88	0
61	69	29	31	31	93	59	7	1	100	89	0
60	70	30	30	30	94	60	6	0	100	99	0

For example, taking $h = 32°$, $h - s = 21°$, and $d = 44°$, as in Sect. IV., we have $93 + 55 + 16 = 164$, whence it appears that the correction is much less than a second; and if $h = 82°$,

TABLE II. Diminution of the Semidiameter.
Argument A (h) + A ($h - s$) + A (d).

Sum of A.	5°	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	30°	45°
	Altitude.													
0″	25″	19″	14″	11″	9″	8″	6″	5″	4″	3″	3″	2″	1″	1″
20	24	18	14	11	9	7	6	5	4	3	2	2	1	0
40	23	17	13	10	8	7	6	5	4	3	2	2	1	0
60	21	16	12	9	8	6	5	5	3	3	2	2	1	0
70	20	15	12	9	8	6	5	5	3	3	2	2	1	0
80	19	14	11	8	7	6	5	4	3	2	2	2	1	0
90	17	13	10	8	7	6	5	4	3	2	2	2	1	0
100	16	12	9	7	6	5	4	4	3	2	2	1	1	0
110	14	10	8	6	5	4	3	3	2	2	1	1	1	0
120	11	9	7	5	4	3	2	2	2	1	1	1	0	0
130	9	7	5	4	3	3	2	2	1	1	1	1	0	0
135	7	6	4	3	2	2	2	1	1	1	1	0	0	0
140	6	5	4	3	2	2	1	1	1	1	1	0	0	0
145	5	4	3	2	2	1	1	1	1	0	0	0	0	0
150	3	3	2	2	1	1	1	1	0	0	0	0	0	0
155	3	2	2	1	1	1	1	0	0	0	0	0	0	0
160	1	1	1	0	0	0	0	0	0	0	0	0	0	0
170	0	0	0	0	0	0	0	0	0	0	0	0	0	0
178	1	1	1	0	0	0	0	0	0	0	0	0	0	0
180	2	1	1	1	1	1	0	0	0	0	0	0	0	0
182	3	2	2	1	1	1	1	0	0	0	0	0	0	0
184	4	3	2	2	1	1	1	1	1	1	0	0	0	0
186	5	4	3	2	2	2	1	1	1	1	1	1	0	*
188	7	6	4	3	2	2	2	1	1	1	1	1	1	*
190	9	7	5	4	3	3	2	2	1	1	1	1	1	*
191	10	8	6	4	4	3	3	2	2	1	1	1	1	*
192	11	9	7	5	4	4	3	3	2	2	1	1	1	*
193	12	9	7	5	5	4	3	3	2	2	2	1	1	*
194	14	10	8	6	5	4	4	3	2	2	2	2	1	*
195	15	11	9	6	6	5	4	4	3	2	2	2	*	*
196	17	13	10	7	6	6	5	4	3	3	2	2	*	*
197	19	14	11	8	7	6	5	5	3	3	2	2	*	*
198	21	16	12	9	8	7	6	5	3	3	3	*	*	*
199	23	17	13	10	8	8	6	5	4	*	*	*	*	*
200	25	19	14	11	9	*	*	*	*	*	*	*	*	*
Alt.	5°	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	30°	45°

$h - s = 63°$, as in the second example, and $d = 104°$, or rather $76°$, $14 + 95 + 1 = 110$, and there is no correction for the moon's semidiameter, when her altitude exceeds 30.

D. *Of the Density of the Atmosphere.*

The corrections for the height of the barometer and thermometer may be taken from the new table in the *Nautical Almanac* for 1822, and applied immediately to the correction of the moon's altitude, (R. T. VIII.) as well as to that of the sun (R. T. Appendix); and they will obviously affect the magnitude of the true altitudes employed in the correct computation. The logarithmic differences of Dunthorne (R. T. IX.) may be readily corrected for temperature and pressure, by adding ·8, or .000008, for every inch that the barometer is *above* 30, and ·05, or .0000005, for every degree that Fahrenheit's thermometer is *below* 50°; or subtracting a similar quantity when the barometer falls, or the thermometer rises.

E. *Example of all the Corrections.*

Let the latitude be 35°, the observed distance of a star from the moon's nearest limb 30° 57′ 12″, the altitude of the lower limb 8° 10′, and that of the star 35° 40′, the height of the barometer 28.70, and that of Fahrenheit's thermometer 78°; the moon's semidiameter at the time being 16′ 22″, and the horizontal parallax 60′ 0″.

A. The augmentation of the moon's semidiameter (R. T.) being 2″, and the diminution for refraction (A) 11″, the correct vertical semidiameter is 16′ 13″.

B. The ellipticity requires a deduction of 4″ from the parallax, making it 59′ 56″ instead of 60′.

C. To find the oblique semidiameter, we have $h = 37°$, $h - s = 1°$, and $d = 31°$, whence the argument is found $90 + 924 + 29 = 1043$, or 43, rejecting the 1000; whence the diminution is 10″, and the oblique semidiameter, instead of 16′ 24″, becomes 16′ 14″.

D. For the density of the atmosphere, the moon's refraction at 8° 26′ requires a diminution of $27'' \times 1.3 = 35''$ for the barometer, and of $2'' \times 28 = 56''$ for the thermometer, making together 1′ 31″; and the star's, at 36°, a diminution of $2'',68 \times 1.3 = 3'',5$, and $'',161 \times 28 = 4'',5$, making 8″: and the correction of the logarithmic difference for the same variations will be $- 1·04 - 1·40 = - 2·44$.

The process, with and without these corrections, will stand thus :—

	° ′ ″	Corrections.	° ′ ″
Star's altitude s	35 40 0		35 40 0
Refraction	1 19	D , − 8″	1 11
True altitude	35 38 41		35 38 49
Moon's altitude	8 10 0		8 10 0
Semid. augm.	16 29	A , − 11″	16 13
App. alt. centre (m)	8 26 24		8 26 13
Lunar correction, T. VIII. for par. 60′	53 10	For par. 59′ 56″	53 6
		D , + 1′ 31″	1 31
True alt.	9 19 34		9 20 50
Distance from the limb	30 57 12		30 57 12
Semid. augm.	16 24	C , − 10″	16 14
	31 13 36		31 13 26
$m \backsim s$	27 13 36		27 13 47
Diff. true altitudes	26 19 7		26 17 59
Log. diff. T. IX.	9.99908·0	D , − 2·4 .	9.99908·1
			9.999057

	° ′ ″			° ′ ″		
Hence vs. d	31 13 36	144877	L. D.	31 13 25	144851	
$m \backsim s$	27 13 36	110797		27 13 47	110821	L. D.
			9.999080			9999657
Diff.		34080	L. .532500		34030	.531862
N.		34008	.531580		33956	.530919
vs. diff. tr. alt.	26 19 7	103657		26 17 59	103512	
				30 23 53		
true dist.	32 25 13	137665			137468	

It appears, therefore, that the neglect of these corrections, especially of that which depends on the density of the atmosphere, may easily produce an error of more than a minute in the moon's distance, which corresponds to half a degree of longitude; and it must be highly worthy of the attention of a practical navigator to enable himself to avoid errors of such magnitude in extreme cases. The errors independent of the density amount, in this example, to about 20″, which is double the supposed greatest error of the existing tables of the moon's motion; so that the habitual correction of these errors is in fact of greater practical importance than the attainment of absolute perfection in the lunar motions without this attention.

iii. *Computations for clearing the Compass of the Regular Effect of a Ship's Permanent Attraction.*

Investigation.

1. A sufficient approximation, for the explanation of many of the phenomena of the dipping needle, is obtained by supposing the magnetism of the earth to be concentrated into two magnetic poles, very near to each other, and to the earth's centre; this supposition being also equivalent to that of an infinite number of small magnets, parallel to each other, distributed equally throughout the earth's surface, or through any other concentric strata.

2. The angular distance of any point on the earth's surface, from the equator belonging to these poles, being called the magnetic latitude, it has been demonstrated by several mathematicians, that the tangent of the dip must be twice the tangent of the magnetic latitude.

3. Hence it may be inferred, that if the sine of the dip be called s, that of the magnetic latitude will be $\frac{s}{\surd(4-3ss)}$.

4. The angle subtended at any point by the two poles will obviously vary as the cosine of the magnetic latitude.

5. Consequently, in the triangle representing the two magnetic forces and their result, either of the two greater angles being ultimately equal to the complement of the dip, it follows that as the cosine of the dip is to the earth's radius, so is the sine of the small angle, subtended by the two poles, to the side corresponding to the ultimate magnetic force in the direction of the dipping needle.

6. The magnetic force in the direction of the dipping needle will therefore vary as the cosine of the magnetic latitude directly, and inversely as the cosine of the dip, or as $\frac{\text{cos. L}}{\text{cos. D}}$; or since $\text{cos. L} = \frac{\text{sin. L}}{\text{ta. L}}$, as $\frac{\text{sin. L}}{\text{ta. L}} \cdot \frac{\text{ta. D}}{\text{sin. D}} = \frac{\text{ta. D}}{\text{ta. L}} \cdot \frac{\text{sin. L}}{\text{sin. D}} = 2\,\frac{\text{sin. L}}{\text{sin. D}}$ $= \frac{2}{\surd(4-3ss)}$; and the magnetic force must vary inversely, as the square root of 4 diminished by three times the square of

the sine of the dip; so that between the magnetic equator and the magnetic pole, the force ought to vary in the proportion of 1 to 2, and the vibrations of a given needle, in a given time, ought to vary in that of 10 to 14.142.

7. This variation of the force is greater than has yet been observed: but on board of the *Isabella*, when the dip increased from 74° 23′ to about 86°, the time of vibration decreased in the proportion of 470 to 436, or 1.078 to 1, and consequently the force increased in that of 1.162 to 1, while the calculation requires an increase in the ratio of 1.095 to 1 only; so that, considering the unavoidable uncertainties of the experiment, the general result of observations, in different parts of the globe, agrees as well with the theory as we have any right to expect, and justifies us in introducing this variation of the force into our calculations, at least as an approximate expression of the facts, *to be compared hereafter with more extensive experience.*

8. The force acting on the needle of a compass, limited to a horizontal motion, is reduced, according to the principles of the resolution of forces, in the ratio of the radius to the cosine of the dip, so that it becomes proportional to $\sqrt{\frac{1-ss}{4-3ss}}$, or inversely to $\sqrt{\frac{4-3ss}{1-ss}} = \sqrt{\left(\frac{1}{1-ss}+3\right)}$.

9. Such being then the magnitude of the horizontal force, acting in the direction of the magnetic meridian, we may readily determine the effect of its combination with another force acting in any other direction, so as to afford a result expressed by the third side of the triangle of forces; for the sine of the angle, formed by this new result with the first line, will be to the sine of the angle which it forms with the second, as the second line to the first; or, in other words, the sine of the angle formed by the actual direction of the needle, with that which would have been its direction if the magnetic force had been undisturbed, will be to the sine of the angle included by its actual direction, and the direction of the disturbing force, as the magnitude of the disturbing force to that of the natural force; and supposing the disturbing force of the ship to be constant in different parts of the globe, the sine of the angular correction, required for its

effect, will vary directly as the sine of the angular distance of the needle from the ship's head, or from any other given neutral line in which the disturbing force of the ship is found by experiment to act, and inversely as the magnitude of the horizontal magnetic force; that is, directly as $r\sqrt{\left(\frac{1}{1-ss}+3\right)}$; r being the sine of the bearing of the ship's head, or other "point of change," as ascertained by the actual indication of the compass, and not by the corrected bearing, which has sometimes been employed in a similar calculation, and s the sine of the dip; the quantity under the radical sign being equal to the square of the secant of the dip increased by 3.

10. If, for example, the utmost disturbance were found to be 5° 40′, where the dip is 74° 23′, its sine would require to be increased, when the dip became 86°, in the ratio of 1 to 3.523, and the maximum of disturbance would become 20° 21′. It is scarcely possible that the calculation should agree better with the result of the observations made on board of the *Isabella:* so that we may employ it, with *some* confidence, for our assistance, in correcting the errors arising from the disturbing force of the ship in all ordinary cases.

11. When the ship's attraction is constant, it is obvious that the two neutral positions, in which it produces no disturbance, will be observed when the ship's head is exactly in opposite directions. But it appears that there is sometimes also an irregular attraction, causing the two neutral points to be within 8 or 10 points of each other; and when this happens, we can only rely on immediate observation, in different parts of the globe, for determining the requisite corrections. This part of the disturbance, however, seems not to increase with the dip, and there is every reason to attribute it to the temporary or induced magnetism of some portions of soft iron; since it may easily be shown, for example, that a horizontal bar of soft iron will lose its effect on the needle in four positions, at right angles to each other, and a bar, so inclined, as to become perpendicular to the dipping needle in the plane of the meridian, will lose its effect in its two opposite positions, in that plane, only, but will act with very different intensities in their neighbour-

hoods, so as to produce different effects in positions diametrically opposite to each other; and from various combinations of such pieces, differently situated, we may easily imagine that all the irregularities, observed in some very few cases, may have originated.

12. *Table of Corrections for clearing the Compass of the regular effect of a Ship's Permanent Attraction.*

Dip.	Apparent distance of the Ship's head or other Neutral Point from the magnetic North, in points							
	1 15	2 14	3 13	4 12	5 11	6 10	7 9	8 8
0°	.5913	.8839	1.0458	1.1505	1.2209	1.2666	1.2926	1.3010
10	.5930	.8856	1.0475	1.1522	1.2226	1.2683	1.2943	1.3027
20	.5983	.8909	1.0528	1.1576	1.2280	1.2737	1.2997	1.3081
30	.6087	.9013	1.0632	1.1679	1.2383	1.2840	1.3100	1.3184
40	.6265	.9191	1.0810	1.1857	1.2561	1.3019	1.3278	1.3362
50	.6573	.9499	1.1118	1.2165	1.2869	1.3326	1.3586	1.3670
60	.7128	1.0054	1.1673	1.2721	1.3424	1.3882	1.4141	1.4226
65	.7575	1.0501	1.2120	1.3167	1.3871	1.4328	1.4588	1.4672
70	.8215	1.1141	1.2760	1.3808	1.4511	1.4969	1.5228	1.5313
71	.8375	1.1301	1.2920	1.3968	1.4672	1.5129	1.5389	1.5473
72	.8550	1.1476	1.3095	1.4142	1.4846	1.5303	1.5563	1.5647
73	.8739	1.1665	1.3284	1.4331	1.5035	1.5492	1.5752	1.5836
74	.8945	1.1871	1.3490	1.4538	1.5241	1.5699	1.5958	1.6043
75	.9170	1.2096	1.3715	1.4763	1.5466	1.5924	1.6183	1.6268
76	.9417	1.2343	1.3962	1.5010	1.5713	1.6171	1.6430	1.6515
77	.9688	1.2614	1.4233	1.5281	1.5985	1.6442	1.6702	1.6786
78	.9988	1.2914	1.4533	1.5581	1.6285	1.6742	1.7002	1.7086
79	1.0322	1.3248	1.4867	1.5914	1.6618	1.7075	1.7335	1.7419
80	1.0694	1.3620	1.5239	1.6286	1.6990	1.7447	1.7707	1.7791
81	1.1113	1.4039	1.5658	1.6706	1.7409	1.7867	1.8126	1.8211
82	1.1590	1.4516	1.6135	1.7182	1.7886	1.8343	1.8603	1.8687
83	1.2138	1.5064	1.6683	1.7731	1.8434	1.8892	1.9151	1.9236
84	1.2780	1.5706	1.7325	1.8373	1.9076	1.9534	1.9793	1.9878
85	1.3539	1.6465	1.8084	1.9131	1.9835	2.0293	2.0552	2.0636
86	1.4498	1.7424	1.9043	2.0091	2.0794	2.1252	2.1511	2.1596
87	1.5732	1.8658	2.0277	2.1325	2.2028	2.2486	2.2746	2.2830
88	1.7482	2.0408	2.2027	2.3075	2.3778	2.4236	2.4495	2.4580
89	2.0486	2.3412	2.5031	2.6078	2.6782	2.7240	2.7499	2.7583

Use of the Table.

Find by observation the greatest disturbance produced by the ship's action on the compass in any given part of the globe, and subtract from the logarithm of its sine the number in the last column of the table opposite to the given dip, the difference will be the logarithm of the constant multiplier for that ship; and if it be added to the tabular number for any other place, or for any other position of the ship, it will give the logarithmic sine of the correction required on account of the *permanent* attraction.

Example.

Supposing the utmost disturbance in the *Isabella* to be 5° 40′, when the dip, is 74° 23′; the numbers of the last column for 74° and 75° being 1.6043 and 1.6268, the difference .0223 becomes, for 23′, .0085, and for 74° 23′ we have 1.6128, which, subtracted from 8.9945, the logarithmic sine of 5° 40′, leaves 7.3817, the logarithm of the constant multiplier for the *Isabella*; then the greatest tabular number for the dip 86° being 2.1596, adding this to 7.3817, the sum 9.5413 is the logarithmic sine of 20° 21′, the greatest disturbance where the dip is 86°; and when the ship's head, or the neutral point, or point of change, appears by the compass to be NE., or 4 points from the magnetic North, the tabular number at 74° 23′ will be 1.4623, and the logarithmic sine 8.8440, answering to 3° 58′; and at 86°, 2.0091, giving the logarithmic sine 9.3908, and the angular correction 14° 14′, so that the true situation of the ship will in this instance be more than a point further from the magnetic North than the compass indicates; it is also obvious, that the correction will be very different from that which would be required, if the actual bearing of the ship's head were NE. or NW.

13. According to the observations collected and computed by the laborious and accurate Professor Hansteen, we have the actual intensity of the magnetic force in different places, as in the following table.

	Dip.	Intensity.
Peru - - -	0° 0′	1.0000
Mexico - -	42 10	1.3155
Paris - - -	68 38	1.3482

	Dip.	Intensity.
London - -	70° 33′	1.4142
Christiania -	72 30	1.4959
Arendahl - -	72 45	1.4756
Brassa - - -	74 21	1.4941
Hare Island -	82 49	1.6939
Davis Straights	83 8	1.6900
Baffin's Bay -	84 25	1.6685
	84 39	1.7349
	84 44	1.6943
	85 59½	1.7383
	86 9	1.7606

14. Notwithstanding the general agreement of this theory, with many of the observations made in the northern seas, it is still possible that some ships may have no *permanent* attraction; and there is reason to believe that the *induced magnetism* of the iron about a ship may not uncommonly have a perceptible effect on the compass; especially as it appears, from Mr. Barlow's experiments, that the guns are to be considered, with respect to magnetism, as soft or conducting. It will therefore be proper to inquire into some of the principal phenomena which may be deduced from this cause.

15. If all the nails and bolts about the ship, together with the guns and ballast, were equally distributed in all possible directions, with respect to their longest dimensions, or even equally distributed into any three different directions perpendicular to each other, the effect on the needle would be very nearly the same as that of a single bar placed in the direction of the dipping needle, or of a sphere or shell of equivalent dimensions; so that it becomes interesting to inquire what would be the effect of such a sphere on the compass.

16. Supposing the sphere to be placed immediately before the compass, and on the same level with respect to the decks, the disturbing force would always completely vanish when the ship's head pointed east or west; so that this is a case which may be excluded from further consideration.

17. In all other cases it may be shown that the needle, if otherwise at liberty, would be directed towards a point in the magnetic axis of the sphere at which it meets a plane, perpendicular to the line joining the sphere and the compass,

and at one third of the distance of the compass from the sphere. The direction of the force referred to the horizontal plane will be the projection of this direction, and its magnitude may be found from the relative latitude of the compass, with regard to the axis of the sphere (N. 6), requiring also to be reduced to the horizontal plane.

18. But, for an easy and useful example of the result of such a calculation, it will be sufficient to take a case in which the primitive directive force of the sphere remains always horizontal, and the reductions are avoided. This will happen when the distance of the sphere before the compass, a, is to b, its depth below the compass, as $\surd\, 2$ to 1; and when the ship's head is at the same time E. or W. Now, the dip being D, the distance of the intersection of the axis with the plane already mentioned, and with the horizontal plane, from the middle of the ship's breadth, will be b cot D, and the cotangent of the spontaneous deviation, $\frac{b}{a}$ cot D $= \surd\, \frac{1}{2}$ cot D, the tangent $\surd\, 2$ ta D, the sine $= \surd\, \frac{2\,ss}{1+ss}$ and the cosine $\surd\, \frac{1-ss}{1+ss}$. The magnetic latitude λ, with respect to the sphere, will be such that $\sin\lambda = \frac{b \sin D}{c}$, c being $\surd\,(a^2+b^2) = \surd\,(2\,b^2+b^2) = \surd\, 3\,b$ and $\sin\lambda = \surd\, \frac{1}{3} \sin D = \surd\, \frac{1}{3}.\,s$; consequently the sine of the dip ε with respect to the sphere is found $\frac{\surd\, \frac{4}{3}.\,s}{\surd\,(1+ss)} = \surd$ $\frac{2\,s}{\surd\,(3+3\,ss)}$: and the magnetic force of the sphere, which varies as $\frac{\sin L}{\sin D}$ (N. 6) or here as $\frac{\sin\lambda}{\sin\varepsilon}$ may be represented by $\surd$ $(1+ss)$, considering the magnetism of the sphere as constant. But the magnetism of the sphere is proportional to that of the earth itself at the place of observation, so that the law of the composition of these forces is not affected by the change of their magnitude: the direct force of the earth, however, requires to be reduced to the horizontal plane, while that of the sphere is already exerted in that plane. The direct force therefore may be called $\surd\,(1-ss)$ and the disturbance

$f\sqrt{(1 + ss)}$: which reduced to the direction of the magnetic meridian, becomes $f\sqrt{(1 + ss)}\sqrt{\frac{1 - ss}{1 + ss}} = f\sqrt{(1 - ss)}$ and to the transverse direction $f\sqrt{(1 + ss)}\sqrt{\frac{2ss}{1 + ss}} = f\sqrt{2}, s.$ The joint force in the direction of the meridian will therefore be always $(1 + f)\sqrt{(1 - ss)}$ and the transverse force $\sqrt{2}.fs$: consequently, the tangent of the angle of disturbance will be $\frac{\sqrt{2}f}{1 + f}.\frac{s}{\sqrt{(1 - ss)}}$, which is proportional to the tangent of the dip, and to that of the magnetic latitude.

19. Hence it appears that the tangent of the angular disturbance produced by the induced magnetism of a mass of iron so situated, when the ship's head is E. or W., will vary as the tangent of the dip. It will also be in opposite directions on opposite sides of the magnetic equator. The disturbance on board the Isabella, in latitude 86°, if derived from this cause, would amount to 21° 19′; and it is remarkable, that conclusions, so nearly agreeing, should be derived from suppositions so totally different.

20. It is not improbable that the soft or conducting iron about a ship may often be so arranged as to produce effects considerably resembling those of a sphere or shell situated before the compass, and as much below it as is here supposed; but the proposition cannot be generally maintained that a sphere may *always* be so placed as to produce effects equivalent to those of the ship's magnetism, however the guns and ballast may be arranged. Supposing, indeed, the guns to constitute the principal part of the iron concerned, the deviation should vary initially in a ratio nearly approaching to that of the square of the sine of the apparent distance of the ship's head from the magnetic meridian, amounting to half of the maximum at about 45°, instead of about 30°, as it commonly appears to do; since the intensity of the induced magnetism of the guns would vary nearly as the simple sine of the distance, and its effect on the compass again as the same sine. The deviation produced by the sphere would follow a very different law, but

it is scarcely probable that this law would agree well enough with the results of observation, to make it necessary to investigate it here in a general manner. It is, however, obvious, that when the compass is in the plane of the magnetic equator of the sphere, the direction of the needle, as influenced by it, will be parallel to the magnetic axis of the sphere, and consequently in the magnetic meridian of the earth, so that the disturbance will disappear, as it did in Mr. Barlow's experiments; and this circumstance, if it were ascertained by observation, would assist us in determining the place of the supposed sphere in the ship. But in the case here stated as an example of the situation of the sphere, the disturbance would never vanish, unless the dip were less than 54° 44′: the cosine of the angle formed by the ship with the meridian, when the force vanishes, being $\sqrt{\frac{1}{2}}$ the tangent of the dip: and this would happen first, in the northern hemisphere, when the ship's head pointed nearly south, while in the situation diametrically opposite, the disturbance would by no means vanish: so that the supposition of an induced magnetism, like that of a sphere, does not appear to be consistent with actual observation. Nor is it possible that a sphere should be so placed as to cause no disturbance whatever at the magnetic equator: and if the disturbance really vanishes at the equator, as has been asserted, it can only arise from an effect resembling that of the induced magnetism of a *vertical bar*.

iv. "*Errors of the Nautical Almanac*" *for* 1822.

Mr. Schumacher, Astronomer Royal of Copenhagen, having had occasion to calculate the moon's place throughout the year 1822 for Greenwich time, in a cursory manner, he has compared his results with the Nautical Almanac for the year. Out of more than 1400 results, 11 only exhibit a difference of 2″; but on the 2d Nov. N. and M. the moon's longitude appears to be put down 4″ too little in the Nautical Almanac, a difference equivalent to an error of 2′, or 2 miles of longitude. The errors of 2″ may be attributed to either series of calculations with equal probability.

The latest comparison of the lunar tables with the Greenwich observations seldom exhibits an error so great as 10″; but in a few instances there are differences of 12″ or 15″.

v. *Observations of the Comet, made at the Royal Observatory, at Greenwich*, 1819.

1819.	Mean Time of Observation.	Right Ascension in Time.	Declination N.	Longitude.	Latitude N.	Sun's Longitude.
	h. m. s.	h. m. s.	° ′ ″	s. ° ′ ″	° ′ ″	s. ° ′ ″
July *3	12 6 55,3	6 51 35,6	43 41 13	3 9 56 3	20 39 54	3 11 7 45
5	12 36 4,1	7 0 9,0	46 25 2			
7	11 53 2,0	7 8 9,5	48 17 41	3 12 28 51	25 33 54	3 14 55 53
8	9 52 34,7	7 11 45,2	48 59 15			
*11	12 6 7,4	7 22 20,0	50 31 22	3 14 40 43	28 6 5	3 18 45 9
*13	12 4 29,3	7 28 34,5	51 7 31	3 15 40 15	28 51 30	3 20 39 32
15	11 9 26,7	7 34 19,4	51 20 11			
18	11 34 38,7	7 42 10,5	51 49 26	3 17 54 41	29 56 10	3 25 24 37
21	11 27 57	7 48 39,0	51 55 0	3 19 1 13	30 13 52	3 28 16 15
*22	11 51 49	7 51 21,0	51 55 24	3 19 29 23	30 19 35	3 29 14 32
*23	11 49 58,5	7 53 27,0	51 54 19	3 19 51 38	30 22 43	4 0 11 48
*24	11 48 5,2	7 55 30,0	51 53 3	3 20 13 26	30 25 42	4 1 9 2
*25	11 46 8,7	7 57 30,0	51 51 23	3 20 34 47	30 28 14	4 2 6 20
*26	11 44 8,7	7 59 26,0	51 49 5	3 20 55 39	30 30 4	4 3 3 37
*28	11 39 59,1	8 3 8,7	51 43 41	3 21 35 58	30 32 52	4 4 58 13
*29	11 37 46,8	8 4 54,4	51 40 27	3 21 55 24	30 33 39	4 5 55 31
*31	11 33 21,0	8 8 19,2	51 33 56	3 22 33 1	30 35 3	4 7 50 8
Aug. 8	11 13 55,6	8 20 22,9	51 5 1	3 24 48 34	30 36 1	4 15 29 5
*9	11 11 21,1	8 21 44,8	51 1 25	3 25 4 6	30 35 58	4 16 26 31
*10	11 8 44,7	8 23 4,1	50 58 1	3 25 19 11	30 36 4	4 17 23 59
*11	11 6 4,6	8 24 20,5	50 54 38	3 25 33 38	30 36 5	4 18 21 30
*22	10 35 21,5	8 36 52,4	50 25 29	3 27 56 3	30 41 48	
*23	10 32 21,1	8 37 50,0	50 23 50	3 28 6 49	30 42 55	
*24	10 29 22,1	8 38 47,5	50 22 16	3 28 17 33	30 44 7	
*27	10 20 20,0	8 41 34,0	50 16 0			

Those marked with an asterisc were observed on the meridian, and are more correct than the others.

vi. *Elliptic Elements of Pons's Comet of* 1819. *In a Letter from Dr.* Olbers.

The year 1819 will always be memorable in the history of comets. It is singular that the small comet discovered by Pons, which appeared in June and July in the Lion, describes an ellipsis, and has a very short period of revolution. From the observations made at Marseilles in June only, Professor Encke found, as you may already have learned from the *Berlin Almanac* of 1822, or from *Zach's Correspondence*, that the orbit was in all probability very remarkably elliptic. The observations made at Milan in July, published in the *Ephemeris* for 1820, have now established this fact beyond all doubt. Professor Encke's elements are these:

Passage of the perihelium, 1819, July 18, 93002 M. T. at Seeberg.

Longitude of the ☊	113° 10′ 45″,8	From the mean equinox, 1 July, 1819.
Perihelium	274 40 51,2	
Inclination	10 42 47,6	
Eccentricity	.75519035	
Logarithm of the M. distance	.4997096	
Period	2051.93 days, or 5 yrs. 7 months.	

By means of these elements the whole of the observations, which Carlini found irreconcilable with any parabola, are represented with wonderful accuracy. Even a difference of half a a year more or less in the period introduces very improbable errors into the observations. A greater degree of accuracy is scarcely to be expected, since we have, unfortunately, been able to find no evidence of an earlier appearance of this comet. One is, however, involuntarily reminded by it of the comet of 1770, which may, perhaps, have had the elements of its orbit very materially altered by the effect of the attraction of Jupiter.

Bremen, 28 *May*, 1820.

The Translation of Dr. Olbers's Essay on Comets will be continued in our next Number.

vii. *Lunar Distances of Venus continued.*

♀ ☽	August 1820. Parisian Time.			
Days.	Noon.	III^h.	VI^h.	IX^h.
25	124° 54′ 45″	123° 5′ 25″	121° 16′ 12″	119° 27′ 5″
26	110 24 12	108 36 19	106 48 41	105 1 22
27	96 9 50	94 24 38	92 39 49	90 55 23
28	82 19 36	80 37 43	78 56 19	77 15 20
29	68 57 12	67 18 57	65 41 9	64 3 48
30	56 4 0	54 29 24	52 55 16	51 21 36
31	43 40 1	42 9 3	40 38 33	39 8 28
Days.	Midnight.	XV^h.	XVIII^h.	XXI^h.
25	117° 38′ 8″	115° 49′ 19″	114° 0′ 44″	112° 12′ 20″
26	103 14 23	101 27 42	99 41 23	97 55 25
27	89 11 24	87 27 48	85 44 38	84 1 53
28	75 34 49	73 54 44	72 15 6	70 35 55
29	62 26 54	60 50 31	59 14 33	57 39 3
30	49 48 23	48 15 37	46 43 18	45 11 27
31	37 28 49	36 9 37	34 40 51	33 12 30

Days.	Hor. Par.	Semid.	Days.	Hor. Par.	Semid.
1	30″,5	29″,0	21	24″,8	23″,6
11	28″,4	26″,9	31	20″ 9	19″,9

♀ ☽ September 1820. Parisian Time.

Days.	Noon.			III^h.			VI^h.			IX^h.		
1	21°	47′	42″	30°	21′	14″	28°	55′	29″	27°	30′	28″
2	20	39	58	19	21	42	17	5	17	16	51	1
3	11	32	57	10	46	50	10	9	51	9	43	34
4	10	39	51									
23	117	49	32	116	2	36	114	17	56	112	32	33
24	103	50	29	102	7	6	100	24	4	98	41	26
25	90	14	12	88	34	0	86	54	15	85	14	16
26	77	5	12	75	28	40	73	52	35	72	16	58
27	64	25	34	62	52	35	61	20	2	59	47	54
28	52	13	32	50	43	53	49	14	38	47	45	46
29	40	26	59	39	0	18	37	35	57	36	7	54
30	29	2	20	27	38	12	26	14	25	24	50	59

Days.	Midnight.			XV^h.			XVIII^h.			XXI^h.		
1	26°	6′	19″	24°	43′	5″	23°	20′	46″	21°	59′	43″
2	15	39	20	14	30	52	13	26	17	12	26	25
3	9	29	42	9	23	35	9	40	38	10	5	0
22	124	55	18	123	8	31	121	22	2	119	35	40
23	110	47	30	109	2	45	107	18	19	105	34	14
24	96	59	10	95	17	19	93	35	51	91	54	48
25	83	36	5	81	57	40	80	19	43	78	42	13
26	70	41	48	69	7	6	67	32	49	65	58	59
27	58	16	12	56	44	55	55	14	2	53	43	35
28	46	17	16	44	49	10	43	21	25	41	54	1
29	34	42	10	33	16	44	31	51	36	30	26	48
30	23	27	55	22	5	13	20	42	54	19	20	56

Days.	Hor. Par.	Semid.	Days.	Hor. Par.	Semid.
1	20″,8	19″,6	21	15″,2	14″,6
11	18″,1	17″,1	30	14″,3	13″,7

♀ ☽ OCTOBER 1820. Parisian Time.

Days.	Noon.			IIIh.			VIh.			IXh.		
1	17°	59	26″	16°	38′	27″	15°	18′	11″	13°	58′	41″
22	122	46	16	121	3	51	119	21	46	117	40	1
23	109	16	38	107	37	5	105	57	55	104	19	8
24	96	11	29	94	35	13	92	59	24	91	24	1
25	83	33	48	82	1	4	80	28	47	78	56	55
26	71	23	53	69	54	30	68	25	31	66	56	56
27	59	39	36	58	13	12	56	47	7	55	21	22
28	48	17	14	46	53	16	45	29	33	44	6	6
29	37	12	18	35	50	10	34	28	13	33	6	27
30	26	19	55	24	59	0	23	38	13	22	17	32
31	15	35	38	14	15	30	12	55	27	11	35	31

Days.	Midnight.			XVh.			XVIIIh.			XXIh.		
1	12°	40′	9″	-	-	-	-	-	-	-	-	-
22	115	58	37	114°	17′	35″	112°	36′	53″	110°	56	35″
23	102	40	47	101	2	50	99	25	17	97	48	10
24	89	49	5	88	14	36	86	40	35	85	6	59
25	77	25	28	75	54	27	74	23	51	72	53	40
26	65	28	41	64	0	54	62	33	27	61	6	21
27	53	55	56	52	30	49	51	6	0	49	41	28
28	42	42	53	41	19	55	39	57	10	38	34	38
29	31	41	50	30	23	21	29	2	6	27	40	57
30	20	56	57	19	36	29	18	16	8	16	55	51
31	10	15	44	8	56	10	7	36	52	6	17	56

Days.	Hor. Par.	Semid.	Days.	Hor. Par.	Semid.
1	14″,2	13″,6	21	12″,3	11″,3
11	13″,6	12″,6	30	10″,1	9″,3

♀ ☽ NOVEMBER 1820. Parisian Time.

Days.	Noon.			III^h.			VI^h.			IX^h.		
1	4°	59′	42″	3°	43′	14″	2°	30′	39″	1°	32′	14″
2	6	3	53	7	23	10	8	42	58	10	3	11
3	16	47	39	-	-	-	-	-	-	-	-	-
21	119	40	52	118	6	13	116	31	55	114	57	58
22	107	13	42	105	41	57	104	10	35	102	39	36
23	95	10	22	93	41	39	92	13	18	90	45	19
24	83	30	50	82	4	58	80	39	27	79	14	15
25	72	12	51	70	49	30	69	26	25	68	3	36
26	61	13	11	59	51	50	58	30	41	57	9	43
27	50	27	36	49	7	45	47	48	0	46	28	21
28	39	51	40	38	32	40	37	13	41	35	54	54
29	29	22	0	28	3	41	26	45	27	25	27	18
30	18	59	12	17	42	0	16	25	5	15	8	17

Days.	Midnight.			XV^h.			XVIII^h.			XXI^h.		
1	1°	21′	10″	2°	17′	50″	3°	29′	16″	4°	45′	34″
2	11	23	40	12	44	23	14	5	18	15	26	24
20	126	2	49	124	26	50	122	51	11	121	15	52
21	113	24	23	111	51	10	110	18	19	108	45	49
22	101	9	0	99	38	46	98	8	56	96	39	28
23	89	17	43	87	50	28	86	23	34	84	57	1
24	77	49	21	76	24	45	75	0	29	73	36	31
25	66	41	1	65	18	41	63	56	37	62	34	47
26	55	48	57	54	28	20	53	7	54	51	47	39
27	45	8	48	43	49	22	42	30	1	41	10	47
28	34	36	9	33	17	29	31	58	54	30	40	24
29	24	9	22	22	51	37	21	34	0	20	16	32
30	13	51	37	12	35	2	11	18	34	10	2	11

Days.	Hor. Par.	Semid.	Days.	Hor. Par.	Semid.
1	9″,9	9″,3	21	8″,5	7″,9
11	9″,3	8″,7	31	8″,1	7″,5

♀ ☽ DECEMBER 1820. Parisian Time.

Days.	Noon.			IIIh.			VIh.			IXh.		
21	120°	46′	36″	119°	19′	30″	117°	52′	40″	116°	26′	8″
22	109	17	37	107	52	44	106	28	8	105	3	48
23	98	5	59	96	43	11	95	20	37	93	58	18
24	87	9	59	85	48	57	84	28	6	83	7	25
25	76	26	33	75	6	49	73	47	13	72	27	44
26	65	51	47	64	32	50	63	13	56	61	55	5
27	55	21	15	54	2	30	52	43	44	51	24	57
28	44	50	36	43	31	34	42	12	29	40	53	20
29	34	16	30	32	56	55	31	37	18	30	17	38
30	23	39	17	22	19	51	21	0	38	19	41	42
31	13	17	23	12	4	47	10	54	59	0	49	6

Days.	Midnight.			XVh.			XVIIIh.			XXIh.		
21	114°	59′	52″	113°	33′	54″	112°	8′	12″	110°	42′	40″
22	103	39	43	102	15	54	100	52	21	99	29	2
23	92	36	12	91	14	20	89	52	40	88	31	14
24	81	46	56	80	26	36	79	6	26	77	46	25
25	71	8	21	69	49	5	68	29	54	67	10	48
26	60	36	16	59	17	30	57	58	44	56	39	59
27	50	6	0	48	47	20	47	28	28	46	9	34
28	39	34	7	38	14	49	36	55	27	35	36	0
29	28	57	56	27	38	14	26	18	31	24	58	51
30	18	23	11	17	5	14	15	48	5	14	32	0
31	8	48	7	7	55	3	7	14	44	6	57	25

Days.	Hor. Par.	Semid.	Days.	Hor. Par.	Semid.
1	8″,0	7″,4	21	7″,3	6″,7
11	7″,7	7″,1	31	7″,1	6″,5

Art. XIV. *Miscellaneous Intelligence.*

I. Mechanical Science.

1. *New hydrostatical Balance, by Benj. H. Coates,* M.D.—This instrument is described in the Journal of the Philadelphian Academy of Natural Sciences. It is an improvement on an instrument before presented to the Academy, and the object in view in making the alteration was to save the labour and inconvenience of calculation. By means of it the specific gravity of a mineral may be ascertained in a few moments, and without pen or ink, or any other assistance than a cup of water.

The lever resembles that of a common steel-yard, and is contrived to balance exactly, by making the shorter end wider, and with an enlargement at the extremity, (see fig. 2, plate III.) The upper edge of each limb is rectilinear, and free from notches, for the sake of accuracy in adjusting the weights.

The shorter end is undivided, but on the larger is inscribed a scale, of which every division, reckoning from the extremity of the lever, is marked with a number which is the quotient of the length of the whole scale, divided by the distance of the division from the end. Thus, at half the length is marked the number 2, at one third 3, at one-fourth 4, *&c.* Also, at two-thirds, the length is marked one and a half, at two-fifths two and a half, *&c.*, and so of all the fractions sufficiently minutely. These numbers extend as high as the specific gravity of platinum. The pivot of the instrument represents unity, and a notch is made at the farther end.

In using this instrument, any convenient weight is suspended by a hook from the notch at the end of the scale. The body under examination is to be suspended to the other end by a horse-hair, and moved along until an equilibrium is produced. It is then, without altering its situation on the beam, to be immersed in water, and balanced a second time by sliding

the weight. The hook of the latter then rests at the specific gravity on the scale.

The demonstration of this is very simple. The instrument being supposed in equilibrium, and the shorter arm, and the weight of the counterpoise being constant, the weight of the body varies as the distance of the counterpoise from the point of suspension or B by the common principle of the lever. Hence if C be the place of the weight at the conclusion of the operation

Weight in water : weight in air : : BC : BA, A being the end of the lever, and, by subtraction, the loss of weight in water : weight in air : : AC : AB : and hence $\frac{\text{weight in air}}{\text{loss}} = \frac{AB}{AC} =$ specific gravity; which is the rule. Q. E. D.

Substances lighter than water may have, if necessary, their specific gravity ascertained by the usual method; a scale of equal parts being cut on the opposite end of the beam, and the article to be weighed placed in a notch for the purpose. For mineralogy, however, this will seldom be necessary. The bottom of the notch A (at the smaller end) should be in a line with the edge of the scale, its sides being a little raised. The top of the shorter end should be rather the thickest part of it to allow the horse-hair, by which the mineral is suspended, to swing clear. This mode will be found very delicate and accurate, and a hook must not be used, as it cannot be balanced.

The instrument in this form is exceedingly compact, and may be reduced to a rod. The principle is capable of being applied to an arc of a circle, with a rod, resembling in its application a common bent lever.

2. *Trigonometrical Surveys.*—For some years past, a trigonometrical operation has been conducted in India, under the auspices of the local governments. Lieut.-Col. Lambton has been enabled, by the aid of their proceedings, to measure, at different periods, an arc of the meridian from 8° 9′ 38″ to 18° 3′ 23″ of north latitude, the greatest that has been measured on the surface of the globe. From a review of the ope-

rations it appears that a degree of the meridian near the equator contains 68.704 English miles; that in 45° of latitude it is 69.03; in 51°, 69.105; in 90°, 69.368. So that a degree of latitude at a medium estimate makes exactly 69.1 English geographical miles.—*Monthly Magazine.*

3. *Geographical Measurements in Denmark.*—During the last two years geographical labours have been carried on in Denmark, under the auspices of the King, for the measurement of degrees from Skagen to the tower of the church of St. Michael, at Strasbourg. These are intended to connect with similar measurements ordered by the governments of Hanover and Bavaria. On the completion of these labours it is intended that the instruments used in them, which are very superior, shall be conveyed to the Mediterranean to be employed in similar undertakings.

His Danish Majesty has also ordered the publication of a *Nautical Almanac* that will contain the distances of the planets from the moon. A calculator has been expressly appointed to act under the directions of M. Schumacher. The first almanac will shortly appear, and will be for 1822.

4. *On the Structure of Glass when in a state of Vibration.*—M. Biot has ascertained that when the particles of plates of glass were made to perform longitudinal vibrations, the glass became altered in structure and affected polarised light. The glass was about 80 inches long, 1.18 inches wide, and nearly .28 of an inch thick. A ray of polarized light was made to fall on a black glass plate at such an angle as to be absorbed, and then the plate of glass being held in the middle, one half was rubbed with a wet cloth, whilst the other was held in the ray before the absorbing glass. Immediately that sound was produced by the friction, the black receiving mirror shone with the light it reflected, but the moment the sound ceased the light ceased also. So that it was evident the glass, whilst in a state of vibration, had the power of affecting the polarized light.

5. *Extraordinary Copper-plate Printing.*—The following is from the Report of the Central Jury, on the production of French industry exhibited in the Louvre, in 1819.

" M. Gonord exhibited, in 1806, porcelain on to which copper-plate engraving had been transferred by mechanical means. He has again appeared at the exhibition of 1819, with some specimens of the same art perfected. He has arrived at a singular but undoubted result. An engraved copper-plate being given he will use it for the decoration of pieces of different dimensions, and by an expeditious mechanical process, enlarge or reduce the design in proportion to the piece, without changing the plate."

In a note, it is said, that " M. Gonord has made a discovery of which the announcement has excited the surprise of the public. If an engraved copper-plate is given to him he can take impressions from it of any scale he pleases. He can at pleasure make them larger or smaller than the plate, and this without requiring another copper-plate, or occupying more than two or three hours. Thus if the engravings of a large atlas size, as for instance, those belonging to the *Description de l' Egypte*, were put into his hands, he would make an edition in octavo without changing the plates.

The certainty of the process has been corroborated by the members of the Jury, who were admitted by M. Gonord into his works. In consequence of their report the Jury decreed a gold medal to M. Gonord.—*Annales de Chim.*, XIII. p. 94.

6. *New Astronomical Observatory.*—An astronomical observatory, similar to that at Greenwich, is about to be erected at the Cape of Good Hope. Mr. F. Fallows, of Cambridge, is appointed astronomer. The situation is well adapted for the advancement of the science.

7. *Improvement in Scissors.*—The usual angle to which the edges of scissors are set is 50°, but varies between that and 55°. This angle was omitted by accident in page 174 of last Number.

8. *New Lamp.*—A new lamp has been invented by Mr. Parker of Argyll-street, which removes a general objection to lamps now in use. It casts no shadow, and can increase its light on the lower or upper part of the apartment at pleasure. Its application is either for reading or general illumination.

II. Chemical Science.

§ Chemistry.

1. *On the Action of Sulphuric Acid on Animal Substances.*—M. Braconnot has continued his researches on the action of sulphuric acid on organic substances, and has obtained some other interesting results in addition to those already published. The following are the most important of them very briefly stated.

12 parts of powdered glue were mixed with 24 of concentrated sulphuric acid. In twenty-four hours the liquor had not increased in colour; about thrice as much water was added, and the whole boiled for five hours, adding water at intervals. The solution was then saturated with chalk, filtered and evaporated spontaneously. In the course of a month it yielded crystals of a very sweet taste, which when washed in weak alcohol, pressed in a cloth, re-dissolved and re-crystallized, were moderately pure.

This sugar crystallizes much more readily than cane sugar. Its solution evaporated by heat forms crystals on the surface. When they are obtained by slow evaporation they form flat prisms or tables grouped together, are hard, and break between the teeth like sugar-candy. They are equal in sweetness to grape sugar, and are not more soluble than the sugar of milk. Their solution does not ferment with yeast. Boiling alcohol does not dissolve them. They are less fusible than cane-sugar, and resist decomposition more strongly. When distilled, an ammoniacal product is obtained. Though it resembles sugar of milk in some points, it differs from it in others. By the action of sulphuric acid sugar of milk is converted into a sugar very soluble in water, whereas this sugar is compara-

tively insoluble. This sugar also is converted by nitric acid, not into mucous acid, but into an acid of a particular kind.

If nitric acid be added to the sugar of gelatine, it does not at first appear to dissolve it, but on heating carefully, a solution is obtained without the liberation of any red vapours, and on evaporation and cooling, a crystalline mass is obtained, which when pressed in paper re-dissolved and re-crystallized is *nitro-saccharine* acid and far surpasses in weight the sugar used.

This acid is very soluble. It crystallizes in beautiful colourless prisms transparent, flat, and striated like Glauber's salt. Its taste is acid and slightly sweet, and resembles that of tartaric acid. When heated it swells, fuses in part, and emits a sharp vapour. It does not affect earthy or metallic solutions. It forms a neutral and a super-salt with potash, which crystallizes in needles; these thrown on coals detonate like salt-petre. It dissolves carbonate of lime with effervescence, and yields needle-form crystals, which are not deliquescent and not soluble in alcohol. Thrown on hot coals these crystals fuse and detonate like nitre. Its salt with copper is crystallizable and unchangeable in the air. Its magnesian salt is deliquescent and uncrystallizable. With lead the salt is uncrystallizable, unaltered by the air, and resembles gum; this salt when thrown into the fire produces a kind of explosion. This acid dissolves iron and zinc, and disengages hydrogen gas. The salts are uncrystallizable.

The action of sulphuric acid on muscular fibre was next examined by M. Braconnot. A portion of beef in small particles was put into much water, and pressed several times to separate every thing soluble. 30 parts of this fibre were mixed with as much sulphuric acid, the fibre softened and dissolved without the production of calour, or the disengagement of sulphurous acid. It was slightly heated, and on cooling, a layer of fat separated from the surface. It was then diluted with water and boiled for nine hours, saturated with chalk, filtered, and evaporated. The extract was not sweet, but had a decided taste of ozmazome. When mixed with potash it

liberated ammonia. Heated, it swelled and burnt, and left a charcoal difficult of incineration. Its solution did not putrefy though retained in a warm place for some time. This extract was boiled several times with alcohol, of the specific gravity of .847. The alcohol being put together, deposited a particular white matter on cooling, which M. Braconnot has called *leucine*.

Leucine in this state was white and pulverulent. In order to separate a small portion of animal matter from it, which was precipitable by tannin, it was dissolved in water, and a small portion of tannin added; after some hours it was filtered, and evaporated until a pellicle formed. Then being left to stand for 24 hours, the bottom of the vessel was found covered with small mammilated crystals of a dull white colour, and feeling brittle between the teeth. If obtained by spontaneous evaporation, the crystals form on the surface in circular masses. The taste of leucine is agreeable, and is that of the juice of meat. Leucine is lighter than water. When heated in a retort, it first melts, a part then sublimes, and forms white opaque crystals, and the fluid which distils over is empyreumatic, and restores the blue of reddened turnsole.

The action of nitric acid on leucine is exactly similar to its action on the sugar of gelatine, but the acid formed is perfectly distinct from the nitro-saccharine acid, and forms distinct salts with saline bases.

The mass which remained, after the action of the alcohol had separated most of the leucine, was like an extract in appearance, of a brown yellow colour, slightly deliquescent, and tasted of leucine.

Wool, acted on by nitric acid a little diluted, and heated, gave results which very much resembled those produced by the fibre of beef.

A summary of the whole is as follows:

1. That animal substances can be converted into other substances, containing much less azote, by sulphuric acid.

2. That this change is effected by the abstraction of hydrogen

and nitrogen, in the proportions fit to form ammonia, and probably by the absorption of oxygen by the sulphuric acid.

3. That gelatine may thus be changed into a very crystallizable sugar, which does not appear to exist naturally.

4. That this sugar combines with nitric acid, without decomposition, and forms a peculiar crystallized acid.

5. That wool, and especially fibrine, with sulphuric acid, form a peculiar white matter, which may be called leucine.

6. That this substance combines with nitric acid, without decomposition, and produces a crystallizable nitro-leucic acid.

7. That other incrystallizable and sapid compounds, analogous to certain vegetable principles, are produced by the action of sulphuric acid on animal substances.

Annales de Chimie, xiii. p. 113.

2. *On the action of Sulphuric Acid on Alcohol and on the new Acids formed.*—Several papers have been published at different times on the change which has been asserted to take place in the sulphuric acid, when employed in the formation of ether. M. Dabit, in the year 1800, published a paper, in which he stated that the acid was deprived of oxygen, and reduced to a state intermediate between sulphuric and sulphurous acid; and being reproached (justly) with a want of experiments in his paper, he, two years afterwards, published another, in which he demonstrated the existence of the peculiar acid he had before asserted. These papers are published in the 34th and 43d volumes of the *Ann. de Chimie.* The formation of the new acid was proved by saturating the residuum left in making ether, with either lime or barytes, filtering and evaporating, a salt of lime or barytes was obtained, which was not a sulphate or a sulphite.

M. Sertuerner has since published an account of three new acids, formed by the action of sulphuric acid on alcohol. He has given them the following names: *acidum protœnothionicum, acidum deutœnothionicum, acidum tritœnothionicum.* The first is formed by mixing equal parts of sulphuric acid and pure alcohol, heating the mixture, and then saturating with chalk; on filtration and evaporation, a salt of the first acid is obtained.

The second is obtained from the residue of the distillation of ether, treated many times with alcohol, this residue is saturated with chalk or carbonate of barytes, filtered, and the salt obtained as before; the third acid is procured by exposing the second acid, or the residuum of ether distillation, to the air for some time, and then saturating and separating as before. The salt is obtained, and from that the acid. A translation of this paper has been published in Thomson's *Annals*, Vol. XIV. p. 44.

M. Vogel has, since these experiments were made, read a paper to the Academy of Sciences at Munich on the same subject. His object was to repeat the experiments of M. Sertuerner, but he does not, in conclusion, admit the existence of three new acids, but of one only, and that appears to be the same as the one described by Dabit.

To obtain it, equal parts of alcohol and sulphuric acid were mixed together, and distilled until all the ether had come off. The residuum was saturated with carbonate of lead, filtered, and a soluble *sulpho-vinate of lead* was obtained. Sulphuretted hydrogen was passed through this solution, which precipitated the lead, and the acid was left pure. The new acid may also be obtained by saturating with carbonate of barytes in the first instance, and then adding sulphuric acid to the salt.

The sulphovinous acid cannot be concentrated by heat, for when heated sulphuric acid is formed in it. But it may be concentrated under the receiver of the air-pump, until it appears as dense and adhesive as sulphuric acid. The specific gravity is then 1.319. If it be left for a long time in the receiver, it decomposes; sulphurous acid is disengaged, and concentrated sulphuric acid, with a few drops of an ethereal oil, are left in the glass.

The sulphovinous acid and the sulphovinates are not decomposed by nitric acid when cold; but, if heated, nitrous acid is disengaged, and sulphuric acid formed. The acid cannot remain pure in its concentrated state for any length of time: after 14 or 15 days, sulphuric acid forms in it.

The sulphovinate of lime when crystallized, is in quadrangular tables, unalterable in the air, but if the salt be obtained in a mass by evaporation, it attracts water. The crystals are slightly

sweet, and are very soluble in water and alcohol. When placed in a vacuum by the side of lime, they lose water, and become opaque; thrown into a hot crucible, they burn with flame, and blacken, but ultimately become white, and are then sulphate of lime. When distilled slowly in a retort, they swell and blacken, an empyreumatic ethereal liquor, and a yellow oil, somewhat resembling the oil of wine, pass into the receiver; then sulphurous acid gas rises, and sulphate of lime, with a little charcoal, remains in the retort.

The sulphovinate of barytes may be obtained by a similar process to that employed in preparing the salt of lime, and when crystallized is in the form of brilliant transparent quadrangular plates, unalterable in the air. They are very soluble in water, but not at all in alcohol. When well washed with good alcohol, they still give in distillation the empyreumatic ethereal fluid, and the yellow oil; from whence it would appear that the oil is not mechanically mixed with the salt, but is in perfect combination.

The sulphovinate of lead is an extremely deliquescent salt. When dry, it requires only half its weight of water for solution, and it is very soluble in alcohol. When distilled, it yields a heavy oil, sulphate of lead, and charcoal.

The sulphovinate of potash is obtained in nacreous scales resembling boracic acid: it feels greasy to the touch; its taste is sweet; it dissolves easily in water; and fuses at a low temperature. The sulphovinate of soda forms in brilliant irregular crystals which effloresce in the air.

Sulphovinous acid acts on iron liberating hydrogen. A colourless solution is formed of a sweet taste, and which is not precipitated by barytes. Four-sided prismatic crystals are obtained by spontaneous evaporation; they are of a pale yellow colour, and effloresce in the air, becoming opaque.

All these salts remain a long time exposed to the air without being decomposed, and many of their solutions may be boiled without the formation of sulphuric acid; it is only the very concentrated solutions which suffer by ebullition.

In comparing the new acid with the hyposulphuric acid,

M. Vogel finds the strongest analogy to exist. They both form very acid colourless solutions, which cannot be concentrated by heat, without being converted into sulphurous and sulphuric acids; are both concentrated in the air-pump to the same extent; both form soluble salts having the greatest resemblance; are both with their salts decomposed by nitric acid yielding sulphuric acid and sulphates. The difference between them consists in the sulphovinous acid containing volatile oil which partly escapes at a high temperature, and is partly decomposed, whilst the hyposulphuric acid is converted by heat into sulphurous and sulphuric acid, without the liberation of any oil, and its salts do not char at a red heat.

From these facts it is deduced that, when sulphuric acid is mixed with alcohol, it loses oxygen, and a new acid is formed. During the formation of ether, therefore, the action of the sulphuric acid is not confined to determining the production of water. The new acid only differs from the hyposulphuric acid in the volatile oil which it contains.

M. Gay Lussac, whilst engaged in examining the above results, prepared the sulphovinate of barytes, and obtained it in rhomboidal prisms, terminated by a rhomboidal pyramid. The crystals were transparent, and did not alter in the air. This salt, when heated, decomposed very readily. It gave a gas, burning like olefiant gas, sulphurous acid, a very little carbonic acid, water, and an ethereal oil, the smell of which, when mixed with the sulphuric acid, resembled acetic ether; sulphate of barytes, and a small quantity of charcoal remained in the retort.

100 Parts, dried in the air, lost by heat 45.07, and gave 54.93 of pure sulphate of barytes; another 100 parts heated, with a mixture of chlorate and carbonate of potash, and then precipitated by the muriate of barytes, gave 111.47 sulphate of barytes, a number nearly double that of the first. So that, with the exception of the vegetable matter, the sulphovinous acid appears to be composed in the same manner as the hyposulphuric, and its capacity for saturation is not changed by the vegetable substance. The vegetable matter appears to act the same part as water of crystallization. It, however, impresses particular cha-

racters on the sulphovinates, many of which differ from the corresponding hyposulphates. The salt of Barytes, for instance, has a different crystalline form to the hyposulphate, and it loses 45.07 by heat, whilst the latter only loses 29.9.

The theory of etherification as given by Fourcroy and Vauquelin, now appears to be deficient. The sulphuric acid yields oxygen to the alcohol, and the result appears to be ether, hyposulphuric acid, and a vegetable substance of an oily nature, resembling the oil of wine. A large quantity of hyposulphuric acid is formed relative to the ether produced, and the sweet oil of wine does not come over before the formation of the sulphurous acid commences; so that it is probable these two bodies are the result of the decomposition of the sulphovinous acid: alcohol in being converted into ether, only requires to lose oxygen and hydrogen in the proportions to form water, but since the sulphuric acid gives oxygen, it must also yield carbon, and it appears to be in the sweet oil of wine that it is deposited.

M. Guy Lussac observes, that it is probable from these new facts, that Welter's bitter principle, and other analgous compounds, contain the acid in the state of nitrous acid.—*Annales de Chimie*, xiii. p. 62, *&c.*

3. *New Acid of Phosphorus.*—M. J. L. Lassaigne has examined the products formed during the formation of phosphoric ether, and finds that an acid of phosphorus is formed precisely similar to the sulphovinous acid. It is obtained exactly in the same way, and forms a soluble salt with lime; which, when heated, gives water, sweet oil of wine, a gas having the odour of acetic ether, carbon, and neutral phosphate of lime.—*Annales de Chimie*, xiii. p. 294.

4. *Researches on the Gluten of Wheat by Dr. G. Taddei.*—"Whilst occupied in examining the flour of wheat, and investigating the cause of its difference from the flour of other grains, I happened to observe, that when the gluten of this wheat was placed in rectified alcohol, it softened, became less coherent,

and filamentous like dense mucus ; finally, it became tenaceous, hard, and less in bulk, having lost a principle which had been dissolved out by the alcohol.

Process to obtain the Gloiodine.—Procure gluten from wheat in the ordinary way, place it immediately in alcohol of 35° (s. g., 842,) or 40° (s.g.817), and work it about with a spatula ; repeat this washing as long as the alcohol on trial becomes turbid on the addition of water. The different portions of alcohol, thus put together, are to be set aside in a close vessel. It will gradually deposit a small portion of gluten on the glass, and become transparent and slightly yellow. The clear solution, when slowly evaporated, yields the gloiodine having the appearance of honey. It is still contaminated with a small portion of a resinous substance which may be removed by sulphuric ether.

Gloiodine may also be obtained from gluten, which has been rapidly dried, and afterwards treated with hot alcohol ; or it may be procured by digesting bruised seeds or wheaten flour in alcohol in the heat of a stove ; but the first process is by much the best when the substance is required pure.

Properties of Gloiodine.—When dry it is of a straw yellow colour, and when in thin pieces somewhat transparent; it is brittle, has a smell somewhat like a honey-comb, and when slightly heated, the odour of apples. It becomes adhesive in the mouth, and has a balsamic taste. It is considerably soluble in boiling alcohol, but is deposited as the temperature diminishes. It forms a kind of varnish on bodies to which it is applied. It softens in cold water, but does not dissolve ; when the water is boiled the gloiodine forms a scum on it, and the water becomes turbid. It is heavier than water. The alcoholic solution of gloiodine is rendered milky by water, and is precipitated by alkaline carbonates in white flocculi. It is scarcely rendered turbid by the vegetable and mineral acids. Dry gloiodine dissolves in the caustic alkalies and in the acids. When heated, it smells and burns like animal substance with a lively brilliant flame, and leaves a light spongy coal, difficult to incinerate; gloiodine, which appears in some points to resemble resinous

bodies differs from them in others. It is insoluble in ether; is extremely sensible to the action of galls; is susceptible of a slow fermentation when alone, and occasions it when mixed with saccharine substances.

On Zimoma.—Gluten, when treated with alcohol as described, is generally reduced about one third in weight, in consequence of the abstraction of the gloiodine and water. What remains is zimoma, which may be rendered pure by boiling it in alcohol, or by continuing to wash with cold alcohol until the last portions of gloiodine are removed. The zimoma then appears in small globules, or in an unformed mass, hard, tenacious, of a greyish yellow colour, and unadhesive. When washed in water it again becomes somewhat viscid, and when exposed to the air changes its appearance, and becomes obscured. It is heavier than water; it does not ferment like gluten, but exhales the odour of putrid urine. It dissolves completely in vinegar, and by boiling in the mineral acids; when acted on by caustic potash; it forms a soapy compound in the alkaline carbonates, and in lime-water it shrinks, wrinkles, becomes harder, and is altered in texture without being dissolved. When burnt, it exhales the smell of skin and horn, and emits flame.

Zimoma is abundantly dispersed in many parts of vegetables, and is the cause of various fermentations, according to the nature of the substance with which it is combined. The term gluten now belongs only to the chemical compound of gloiodine and zimoma.—*Giornale di Fisica,* 2. p. 360.

5. *Gluten an Antidote for Corrosive Sublimate.*—During the researches undertaken by Dr. Taddei on gluten and on wheaten flour, he discovered that gluten had the property of acting on the red oxide of mercury, and on corrosive sublimate. If it be mixed with either of these substances it immediately loses its viscidity, becomes hard, and is not at all liable to putrefaction. Further, if flour be made into a paste, with solution of corrosive sublimate, it is impossible to separate the gluten and starch in the usual way. This effect induced Dr. Taddei to suppose, that in cases of poisoning by corrosive sublimate,

wheaten flour and gluten would prove excellent antidotes to the poison. It was found by experiment, that wheaten flour and gluten, reduced corrosive sublimate to the state of calomel; and also that considerable quantities, of a mixture of flour or gluten with corrosive sublimate, might be eaten by animals without producing injury; thus fourteen grains of sublimate have been given in less than twelve hours to rabbits and poultry without injury, whereas a single grain was sufficient to produce death when administered alone. A grain of the sublimate required from twenty to twenty-five grains of fresh gluten to become innocuous; when dry gluten was used half this quantity was sufficient, but when wheaten flour was taken, from fifteen to eighteen danari, (500 or 600 gr.,) were required. Dr. Taddei recommends that dried gluten be kept in the apothecaries' shops, and that it be administered when required, mixed with a little water.—*Giornale di Fisica,* 2. p. 375.

6. *New Vegetable Alkalies—Piperine.*—M. Oersted announces the addition of two new vegetable alkalies to those already known. One of these, to be called Piperine, is obtained from pepper, by digesting it in alcohol; muriatic acid is to be added to the alcohol, and then water; the resin is precipitated, and the muriate of piperine remains in solution. The solution is to be evaporated for some time, and then decomposed by pure potash, which precipitates the new alkali.

Piperine is nearly insoluble in cold water, and only very slightly in boiling water. It dissolves in alcohol, and the solution has a greenish yellow colour, which by the addition of nitric acid is rendered a perfect green. Piperine is very acrid. With sulphuric and acetic acids it forms salts nearly insoluble in water. The muriate is moderately soluble. The capacity of saturation appears to be very small.

M. Forchhammer has found a new alkali in the fruit of the capsicum annuum. It is extremely acrid. It is more soluble in water, and has a greater capacity of saturation than the other vegetable alkalies. It forms a triple salt with the protoxide of lead and muriatic acid, which is as acrid as the alkali itself.—*Journal de Physique,* 1820, p. 173.

7. *Specific Heat of Gases.*—The following table of the specific heat of gases is from the Memoirs of M. M. Desormes and Clement on Heat, published in the *Journal de Physique.* It is given for equal volumes, at temperatures from 0° to 60 centigrade.

Gas.		Inches.	Results according to M. M. Delaroche and Berard.	Desormes and Clement.
Atmospheric air	at	39.6	1.2396	1.215
Ditto	at	29.84	1.	1.
Ditto	at	14.92		0.693
Ditto	at	7.44		0.54
Ditto	at	3.74		0.368
Do. charged with vapour of ether	at	29.84		1.
Nitrogen	at	29.84	1.	1.
Oxygen	at	29.84	0.974	1.
Hydrogen	at	29.84	0.9033	0.664
Carbonic acid	at	29.84	1.2583	1.5
Oxide of carbon	at	29.92	1.034	
Oxide of nitrogen...........	at	29.92	1.3503	
Olefiant gas	at	29.92	1.553	
Vapour of water at .102°.2 F.	at	29.92	1.96	

The relative specific heat of water and air by weight is, according to M. M. Delaroche and Berard, as follows :—that of water being 1000., that of air was found, by three different methods, to be 249.8—281.3—and 269.7.—M. M. Desormes and Clement found that of air to be 250.

M. M. Desormes and Clement have been searching after the absolute zero, and are convinced that it is at 266°.66 below the zero of the centigrade scale, or at—446°. F.

8. *On Cadmium, by J. G. Children, Esq.*

My dear Sir,—I take it for granted that the mode of separating cadmium from zinc, which Mr. Cooper, at page 192 of the 9th volume of the *Journal of Sciences and the Arts,* considers "rather *fallacious,*" is that suggested by myself in a former Number, Vol. VI. p. 228. I do not know what "rather fallacious" means ; either the mode is effectual, or it is not. Neither is it my business to inquire why "it did not succeed in Mr.

Cooper's hands." But this I know, that if all the substances be pure, it cannot fail in any one's. To a neutral solution of nitrate of zinc, I added pure ammonia, just sufficient to re-dissolve the precipitate it at first occasioned. A solution of pure potassa (prepared by Mr. Garden,) was then added, drop by drop, which at first occasioned a little cloudiness, that disappeared, on agitating the vessel; more alcali reproduced a slight precipitate, but a small excess immediately and perfectly re-dissolved it. The solution remained quite clear, without the slightest deposit, after standing eighteen hours in a close stopped phial; it was then exposed in a small precipitating glass to the air for twenty-two hours longer, at the end of which time the fluid was still perfectly clear, but a small quantity of crystalline matter had collected at the bottom of the jar. When a similar experiment was made with potassa, not perfectly pure, a portion of oxide or carbonate of zinc remained permanently precipitated from the first, and its quantity was considerably increased at the end of eighteen hours. Sulphuret of cadmium, dissolved in muriatic acid, and filtered and treated exactly as the nitrate of zinc, gave, with Garden's potassa, a precipitate, which a great excess of the alcali did not re-dissolve.

A few drops of a solution of nitrate of cadmium were mixed with a large proportion of a solution of nitrate of zinc, and the mixture treated successively with pure ammonia and potassa as before; an immediate and permanent precipitate ensued on adding the potassa, which, when collected, washed, and re-dissolved in muriatic acid, gave, with sulphuretted hydrogen, the peculiar yellow precipitate characteristic of sulphuret of cadmium.

After all, the simplest method of detecting cadmium is the following, which Dr. Wollaston had the goodness to teach me: Precipitate all the metals by iron which can be so separated; filter and immerse a cylinder of zinc into the clear solution. If cadmium be present, it will be thrown down in the metallic state, and when re-dissolved in muriatic acid, will exhibit its peculiar character, on the application of the proper tests.—I am, *&c.*

Montague-place, April 3, 1820. JOHN GEO. CHILDREN.

P. S. Nothing so much assists the young practical chemist as

the study of a skilful analysis; it is matter of regret therefore that Mr. Cooper has not given the *details* of his experiments on the brown mamillated blende, which is the subject of his communication.

9. *Preparation of Nitrate of Silver.*—M. Brandenbourg has an economical method of separating silver from copper, in the preparation of nitrate of silver from the alloys of silver. He dissolves the alloy in nitric acid, and having evaporated the nitrates to dryness, places them in an iron spoon, and fuses them until ebullition ceases. The fused mass is then poured on an oiled slab. A small portion of it is tested for copper, by solution in water, filtration, and ammonia. If it is found, by the blue tint, still to contain copper, the fusion is continued a few seconds longer. The mass is now a mixture of nitrate of silver and black oxide of copper. It is to be dissolved in water, filtered, evaporated, and crystallized, and the pure nitrate of silver is obtained.

10. *Urate of Ammonia Calculi.*—Dr. Prout has met with one of those rare calculi which are formed of the urate of ammonia. It weighed, when entire, about 50 grains. Its general shape was ovoid, a little flattened, its external surface was smooth, and of a greenish clay colour. It was composed of thin concentric layers, easily separable from one another, and readily breaking into sharp angular pieces, with a compact earthy fracture. Its general colour internally differed, both in shade and intensity, from that of its external surface; it might be denominated a pale reddish clay colour. The different layers differed, however, somewhat in intensity, which caused the laminated structure to be visible to the eye. Between some of the layers also there were minute depositions of the earthy phosphates, which rendered the structure still more visible. The nucleus exhibited the same general appearance as the rest of the calculus, except that it appeared to be made up of a fine powder, and a few larger grains loosely agglutinated together. It was sparingly soluble in cold water, but it dissolved readily in boiling

water, requiring only about 300 times its weight for that purpose. On cooling, the calculous matter did not immediately separate, but after some days a great part of it was deposited. When chemically examined it was evidently urate of ammonia.

Dr. Prout also possesses a fragment of another small calculus, having precisely the same colour and properties with that described. It was taken from a boy under the age of puberty, and was accompanied, as was also the first, by great irritation.

The characteristic properties of this species of calculus appear to be the following: 1. Their colour and general appearance, which are peculiar, 2. Their solubility in water. 3. Their yielding ammonia, when treated with fixed caustic alkali. To which, perhaps, may be added, 4. Their property of decrepitating before the blow-pipe.—*Medico-Chirurgical Transactions,* x. p. 389.

11. *Properties of Lithia.*—Dr. Gmelin, of Tubingen, has been engaged in experiments on lithia and petalite. He obtained pure lithia by adding barytes-water very carefully to sulphate of lithia, until nothing remained in solution but the caustic alkali. The solution was rapidly filtered into a tubulated retort, and evaporated in a sand-bath. When the liquid in the retort became concentrated, a white powder separated, and likewise some small granular crystals. These fell while the liquid was still hot. The retort, still closed, was then placed in a cellar. Neither the powder nor crystals appeared to increase on cooling, and hence it is considered that lithia is not much more soluble in hot, than in cold, water. The concentrated solution being then evaporated in a platinum crucible by a spirit-lamp, dry caustic lithia was obtained, in which acids could detect no trace of carbonic acid.

When heated in a platinum crucible it melted before it became red hot. The fused mass was transparent, but on cooling in the open air became opaque, from the absorption of carbonic acid. Caustic lithia has a sharp burning taste. It destroys the cuticle of the tongue, and appears to equal potash in

causticity. It does not dissolve very readily in water, and seems to be nearly soluble alike in hot or cold water. In this respect it resembles lime. It evolves heat on solution.

Alcohol, of sp. gr. ,85 dissolves only a small quantity. Weak alcohol, added to an aqueous solution of lithia, in a well-closed vessel, forms, after some hours, a precipitate of lithia, in the state of a white powder.

Phosphate of lithia appears to be insoluble in water. When phosphoric acid is dropped into solution of sulphate of lithia, there is no precipitate. But when the acid is saturated with ammonia, the phosphate of lithia falls in the state of white flocks. When a drop of phosphoric acid is put into a very weak solution of carbonate of lithia, no precipitate is formed, but on heating the liquor the carbonic acid gas is disengaged, and phosphate of lithia falls.

In consequence of the insolubility of the phosphate of lithia, an easy means is offered of separating this alkali from potash and soda. The lithia may be precipitated by means of phosphoric acid and excess of ammonia. The phosphate of lithia may be dissolved in acetic acid, and the phosphoric acid be precipitated by means of acetate of lead. The acetate of lithia, which remains in solution, may afterwards be treated in any way that may be required.

Dr. Gmelin has had occasion to observe, during his experiments, the effect of boracic acid in reddening turmeric paper. This effect, as well as similar effects of other acids, were pointed out some time ago in this Journal, Vol. V. p. 125, and Vol. VI. p. 152. It does not take place when paper tinged with rhubarb is used.

12. *Sulphate of Magnesia.*—M. Gay Lussac has lately experimented on the sulphate of magnesia, and finds that the proportions given by M. Longchamp are not correct, but that the old numbers are very near the truth. The sulphate of magnesia, when crystallized, contains,

Dry sulphate of magnesia......	48.57
Water	51.43
	100.

The equivalent number for sulphate of magnesia is 24.7129. For the dry sulphate, 74.8294, and this quantity combines when in the crystalline form, with 79.236 of water, or seven proportions.—*Annales de Chim.* xiii. p. 308.

13. *Test for Copper and Iron.*—The ferro-cyanate of potash has long been used as a test for copper and iron in solution, and it is hardly possible to imagine any thing more sensible than its indications. M. Brandenburgh, however, recommends, as superior to it, the ferro-cyanate of ammonia (prussiate of ammonia and iron). It is easily prepared by pouring ammonia on to Prussian blue in a phial, which must be closely stopped. About six of the former to one of the latter may be used at first; and if, in the course of three or four days, the whole of the sediment has become brown, more of the Prussian blue is to be added, until it ceases to change colour. The solution is then filtered, that which remains adhering at first to the residuum, being passed through by washing, and is then preserved for use. It should be of a fine yellow colour.

14. *Properties of Native Naphtha.*—Dr. Thomson has lately ascertained the properties of native naphtha. The specimen on which he worked came from Persia, and was very pure. It was perfectly colourless, and had the taste and smell of the naphtha which is made in this country from coal. Its specific gravity was .753. The lowest specific gravity observed of naphtha made in this country was .817. It was not very volatile; it boiled at 320°; and if the boiling were continued, the temperature would rise up to 338°, and in a silver vessel even to 352°. This gradual rise of temperature Dr. Thomson is inclined to attribute to a partial decomposition of the naphtha by the heat.

From an attempt to analyze it, by passing one grain of it through heated peroxide of copper, the following composition was deduced:—

13 atoms carbon...... 9.75
14 atoms hydrogen.... 1.75

A deficiency of 3 per cent., however, remains, which Dr. Thomson was inclined to think is nitrogen.

15. *New Animal Soap.*—M. Geoffroy de Villeneuve has lately transmitted a quantity of a peculiar kind of soap, from Africa to Paris, with the following note :—" Being in the village of Postudal, a few leagues from Senegal, employed in collecting insects, and inviting the negroes to procure me supplies, one of them presented me with a pot containing many thousands of a small insect of the carab genus. They were ready dried, and the numbers shewed that they had been collected for some particular purpose. On inquiring, I learned that this insect entered into the composition of the soap used in the country; the same negro also shewed me a ball of this soap, which was of a blackish colour, but had all the properties of our common soap; and I learned, in the sequel, that these insects are converted to the same purpose all along the coast of Senegal. This carab is black, but the edges or borders of the corselet, and also the elytres, are of a reddish colour; the feet and the antennæ, of a pale colour."

16. *Oxalate of Potash and Manganese.*—When the black oxide of manganese and the super-oxalate of potash are triturated together, and moistened, there is considerable effervescence occasioned by the formation of carbonic acid gas; and if more water be added, and the whole filtered, a red solution of an admirable colour is obtained. This solution is neutral, and is a triple oxalate of potash and deutoxide of manganese. If, however, it be left some time, it loses colour; the manganese takes the state of protoxide, and a colourless triple salt is obtained. We are indebted to M. Van Mons for the knowledge of this interesting decomposition.

17. *Platinum Leaf.*—Platinum is now prepared, in Paris, in leaves as thin as those of leaf gold.

18. *Evolution of Heat by Freezing.*—M. de la Beche has devised an ingenious way of shewing the heat evolved by water during congelation. He places a glass vessel, containing in its lower part water, and upon that olive oil, in a temperature

below the freezing point of water. In this temperature, olive oil alone would freeze and thicken, but being placed over water, it is retained in the fluid state, in consequence of the heat evolved by the water during its conversion into ice; and it is not until the whole of the water is perfectly frozen, that the oil itself will freeze.—*Bibliothèque Universelle,* xiii. 76.

19. *Formation of Succinic Acid.*—Dr. John, of Berlin, states that he has formed succinic acid by treating 2lbs. of bread, 1½lb. honey, 1½lb. of the fruit of the ceratonia siliqua, 2 pints vinegar, 2 pints spirit, and 28 pints water, in such a way as to make them undergo the acetous fermentation. The vinegar formed was saturated with lime, and the acetate obtained by evaporation. 24oz. of this salt, triturated with 1oz. peroxide of manganese, were mixed with 16oz. of sulphuric acid, and 13oz. of water, and then distilled. When no more acid came over, the receiver was charged, and the fire increased, and a sublimate of succinic acid came over, which condensed in the neck of the retort. When purified, it weighed two drachms.

As the process, on repetition, always gave succinic acid, though the fruit of the ceratonia siliqua, on analysis, gave none, Dr. John concludes that the acid was formed during the operations.

20. *Assay of Soda of Commerce.*—M. M. Welter and Gay Lussac, in a paper on the assay of soda, and the salts of soda of commerce, by sulphuric acid, as is usually done, recommend that the portion of soda taken should be first heated with a little chlorate of potash. This is done to convert any sulphuret or sulphite of soda into sulphate; otherwise those substances are saturated by the test sulphuric acid, and appear as soda in the results, though they are of no use as such in the arts. The soda of commerce is frequently contaminated with those two bodies, and in every case where they exist, an error will occur unless their effect be prevented as above. After the action of the chlorate of potash, the test acid is applied carefully in the usual manner.—*Ann. di Chim.* xiii. p. 212.

21. *Chemistry applied to industrious Economy.*—A new method of killing animals, without causing them pain, has been adopted in London: they are made to expire by means of nitrogen gas. By this means the meat is rendered much more fresh, of a more agreeable taste, and may be preserved for a greater length of time. A great number of the butchers of London already employ this process.—*Revue Encyclopédique*, tom. v., p. 185.

22. *Red Fire.*—The beautiful red fire which is now so frequently used at the theatres, is composed of the following ingredients:—40 parts dry nitrate of strontian, 13 parts of finely powdered sulphur, 5 parts of chlorate of potash (oxymuriate of potash), and 4 parts of sulphuret of antimony. The chlorate of potash and sulphuret of antimony should be powdered separately in a mortar, and then mixed together on paper; after which they may be added to the other ingredients previously powdered and mixed. No other kind of mixture than rubbing together on paper is required. Sometimes a little realgar is added to the sulphuret of antimony, and frequently when the fire burns dim and badly, a very small quantity of very finely powdered charcoal, or lamp-black, will make it perfect.

III. Natural History.

§. 1. Mineralogy, Geology, *&c.*

1. *Carbonate of Iron.*—M. Berthier has found carbonate o iron in the department of l'Yonne, near the village of Burain dispersed through a bank of ochre, and the sandy clays that accompany it. The ochre rests upon a compact argillaceous limestone. The carbonate of iron occurs in irregular rounded masses; sometimes of a large size, and distributed here and there without any order. These pieces are of a brown colour, without lustre, heavy, not hard. They disintegrate on exposure to the air, and crumble between the fingers. At first sight they appear like a mixture of bituminous clay and pyrites in very minute grains; but when attentively examined, prove

to have a globular structure like the oolite. The globules are extremely small, and are attached together by a small portion of clay, which is easily washed out by water. When a portion of the mineral, which has fallen to powder in the air, is treated with muriatic acid the brown colour disappears, and the globules become clear, resembling pure carbonate of iron. They dissolve slowly but totally. When analyzed 200 parts gave

Carbonate of iron..........	81.2
Carbonate of magnesia......	5.8
Water	2.0
Clay	11.0
	100.0

The name of globular, or oolitic argillaceous carbonate of iron, is proposed for it.—*Annales des Mines*, iv. p. 633.

2. *Conite.*—Dr. Mac Culloch, in his account of the Western Isles of Scotland, described a new mineral, which he found in Mull and in Glen Farg, and to which, from its powdery form, the name of conite was given. Since this he has discovered it in the trap of the Kilkpatrick hills and also in Sky.

3. *Tin Mines of Banca, &c.*—The tin mines of the Malay Peninsula are confined between the 10th degree of north and the 6th degree of south latitude. It is in the isle of Junck-Ceylon, that this metal is the most abundant: the produce surpassing sometimes 800 tons per annum.

Quidah, Prio, and Pera, ports of the Peninsula, are places to which the natives bring large quantities of tin from the interior. It is there sold for ten or twelve dollars, or three pounds sterling per picul, weighing 133 pounds, equal to forty-eight pounds sterling the ton, and it is resold in China at eighty pounds the ton.

The tin of the isles of Banca and Lingin is always at a less price; and it is said, that the Dutch made an arrangement with the Malayan merchants of Banca, by which the latter were to sell it to them at six dollars the picul. In certain years more

than 3,000 tons of the metal are raised at Banca and Lingin, the greater part of which is carried to China. It is preferred there to the Cornish tin, which is imported by the East India Company. In 1813, 150 tons of Banca tin, which were not disposed of in China, were imported into England by the Company with great advantage.

The difference of price which exists between the tin of Cornwall and of the East Indies in the East, depends on the great richness of the Banca mine, and the facility of working it. No expensive machines are employed in the operation, and though the mines have been in full work for many centuries, still access to the unexhausted parts is very easy. The works are carried on by a Chinese colony established at Banca.

Some authors say, that the Banca mines were discovered only about the year 1710 or 1712; but the Portuguese in their first expeditions found the ships of the country laden with this metal, and it is known that the Arabs carried it to China in the ninth century.

In many of the Malay ports, where ships resort to purchase tin, it is usual to run it over again, for it is sometimes offered for sale full of stones and dust. The instrument they use is a broad cast-iron pan, of Chinese manufacture, called a *tacht*. Wood is the combustible used, and the fire-place is as rude as possible. At Junck-Ceylon the mineral is pounded in mortars of wood by pestles shod with iron; these are fixed to a lever seven or eight feet long, which is moved by a man with his feet. Before reducing it to powder, the mineral is stratified with small wood, and roasted in pits made in the earth. A considerable quantity of pure tin is obtained by the first process.

The mines very often have naturally the form of large caves, which very much facilitate the removal of the ore; and, after its abundance, is an important cause of the cheapness of the metal. The men who are employed to melt the metal at Quidah receive three dollars per month, and their food, which is worth about a dollar and a half per month: one with the other they get rather less than a shilling a day.

The ore is carried by water to Quidah, a distance of several days' journey. Here it is reduced, and the metal made into a variety of fantastic forms; some are small cakes of about three pounds each, others are poultry, dogs, water-pots, cauldrons, *&c.*, of all sizes; but more generally it is made into slabs, of fifty, sixty, or eighty pounds, weight, or into balls, cylinders, or other convenient forms, and with projecting parts or handles by which to move them.—*Asiatic Journal, or Bombay Gazette, July* 7, ix. p. 33.

4. *On the Water-spout.*—Sir,—Some years since whilst cruising off Prince's island, on the coast of Africa, I had an opportunity of observing a water-spout of singular size and beauty; it approached the sea, at an angle of about 45°, until entering a large cloud, it appeared to suffer considerable refraction in its passage through it, for immediately on leaving that medium, it assumed a direction nearly perpendicular to the horizon. The accompanying Paper is an extrtact of a letter from a gentleman in the Azores, who, in giving an interesting detail of the celebrated volcanic eruption of 1811, seems to have thrown some light on the origin of the water-spout, a phenomenon hitherto so little understood.—I am, Sir, your obedient servant,

7, *High-row, Knightsbridge,*
June, 1820. T. M. Bagnold.

5. *Account of the Formation of the Island of Sabrina off the Island of St. Michael.*—On Thursday morning, the 13th of June, 1811, at about half-past one o'clock, a strong shock of an earthquake was felt at the city of Ponta Delgada, and for nearly eight hours the shocks continued with more or less violence, with intervals of from fifteen to twenty minutes between each shock, and more particularly at the west end of the island, where a number of cottages were thrown down, and other more substantial buildings considerably injured. On Friday morning a submarine volcano burst forth, about a mile from the shore, to the N.N.W. ½ W. of the Pico das Camarinhas, which threw

up stones and sand to a considerable height, but it subsided in the afternoon of the same day. On Saturday, the 15th, the volcano burst forth again in the same place, though not with so much violence; the shocks of the earthquakes were also more mild, but considerable damage had already been done in the districts of Ginetes, Varzea, and Morteyros. On Sunday morning early, accompanied by some friends, I rode to the west end of the island to observe this phenomenon, and was much gratified at seeing one of the most awful and sublime spectacles that nature can present to human observation. I took my station on the brink of a steep precipice, impending over the sea-shore, at the nearest possible distance from the volcano, which was raging with immense fury, throwing up stones and sand to a height of upwards of a thousand feet above the level of the sea, attended with a hollow thundering noise, like a distant cannonade, and accompanied with some smart shocks of earthquakes. The mephitic vapour was at times so strong, as to affect the breathing, even to danger of suffocation, as the wind blew direct on shore from the N.N.W. The sea was agitated around the volcano, to a considerable distance, and boiling like an immense cauldron, the diameter of which appeared to be about 500 feet; the stones (some of which were apparently above a ton weight), being thrown up nearly perpendicular, several hundred yards, fell with tremendous noise in every direction about the volcano, and kept the sea in a continual foam. The appearance of the clouds, rising in a spiral form, and spreading several leagues to the southward, attracted particular notice, from the water-spouts which formed from the black denser clouds, and drew up the water in a variety of directions,—at one time I counted eleven water-spouts in full action; occasionally the clouds burst over us with light rain, charged with ashes and small scoria, drawn up from the volcano; the smell of sulphur was so strong as greatly to incommode the inhabitants of Ponta Delgada, a distance of nearly twenty miles. On Tuesday, the 18th of June, I returned to the same spot, accompanied by Captain Tillard, of His Majesty's ship Sabrina, Mr. Nicholes, purser of that ship,

and a Portuguese gentleman, and on our arrival at half-past ten, we discovered the mouth of a cràter, several feet above the surface of the sea; the quantity of sand and ashes thrown up from the centre of the crater, formed an embankment as it fell, which kept out the sea, except in one place, where an *embouchure* of about thirty feet wide was discernible; the sea rushed into this part with incredible fury at every interval of the eruption, which subsided only for a few minutes, returning with redoubled force; in less than three hours the crater had increased in height above the level of the sea nearly sixty feet; having a pocket-compass, we took the bearings of the volcano, and having measured a base line of 800 feet, we found the distance from the spot of observation to be 5,100 feet, or nearly an English mile. About one, P.M., a most tremendous explosion took place, which lasted nearly twenty minutes, and darkened the atmosphere for several miles around; the flashes of lightning were very vivid, and produced a grand effect on the black dense smoke of the volcano; the rocks thrown up were red hot, and caused a hissing noise on falling into the sea, which was distinctly heard at intervals, when the subterraneous thunder ceased: part of the cliff, on whose banks we were seated, fell into the sea, from the shock of an earthquake, and obliged us to make a precipitate retreat for fear of a repetition. At five o'clock we quitted this awful scene with reluctance; nothing could exceed the gratification felt by all parties: on our road to the city we had frequent opportunities of observing the damages done by the earthquakes: many cottages were entirely thrown down, and others totally uninhabitable; the roads were choked and almost impassable, from the hills having fallen in upon them in various places. On the following day, Captain Tillard being anxious to have a view of the volcano from the ship, he invited a party to take an excursion by water, and I had the pleasure of making one. On rounding the west end of the island, we found that the volcano during the night had increased to a mountain, nearly conical, whose base formed almost an equilateral triangle, so that within the space of a few hours it had increased upwards of 600 feet in

height, and was still in full action; in passing to leeward of it, nearly six miles distant, some of the clouds burst over the Sabrina, and covered the ship with sand and ashes, so as to oblige the ladies to leave the deck; another grand explosion took place about four P.M., and at six a repetition. During the night the volcano was pretty quiet; at intervals streams of fire were discernible, but it coming on to blow hard from the N.W., we were obliged to keep a good offing; at day-light the next morning we returned to Ponta Delgada. Since the 22d the eruptions have entirely ceased; a strong smoke, however, continues to issue from the centre of the crater, which is still boiling, and the water of the sea is perfectly warm, at the distance of more than half a mile from the island. Several persons have landed on the island, but found the ground so hot as to oblige them to re-embark immediately; had the eruption continued much longer, in all probability a safe harbour would have been formed between the volcano and the Bahia dos Mosteyros. About a century ago, an eruption broke out on the land, which burnt for several months. The extinct crater is composed of lava, pumice, and calcined earth and sand, which, having been in a state of fusion, resembles the dross of ore.

6. *Height of Monte Rosa.*—Sir: Allow me to correct an error which appears in the last Number of your Journal. In page 196, the height of Monte Rosa is said to be 4521.77 metres, or 33,530 feet. As this would vastly exceed even the Himáláyá mountains, I was induced to repeat the calculation. The tables give me the French metre equal to 39.371 inches and 3281 feet: I have calculated it both ways, and obtained the same result, namely, 14,836 feet English.

7. *New Island off Cape Horn.*—A new island has been discovered off Cape Horn, in lat. 61°, long. 55°, by the ship William, on a voyage from Monte Video to Valparaiso. The same ship having been despatched by Capt. Sheriff, of the Andromache frigate, to survey the coast, explored it for 200 miles. The Captain went on shore, and found it covered with snow, and un-

inhabited; abundance of seals and whales were found in its neighbourhood. He has named it New Shetland.]

§ II. Medicine.

1. *On the Use of Prussic Acid in Consumptive Cases.*

(From the Halifax N. S. Weekly Chronicle.)

We have been politely favoured by Dr. J.R. Henderson of this city, with a copy of the following highly interesting letter from Professor Smith, of Columbia College, S. C., *&c.*:

Columbia, S. C. June 15, 1819.

Sir—This communication will evince that you have not made an erroneous calculation of professional liberality in your letter addressed to Dr. Davis and myself, and received yesterday. I recollect that when Mr. Silliman gave me a call, Dr. Davis and myself were conversing upon the encouraging prospects of relieving *Phthisis Pulmonalis,* by the use of the Prussic acid, and no doubt from this Mr. S. was led to make the observation to you.

We are both desirous to extend the honour and benefit of the Medical Profession; and for this purpose, by the desire of Dr. Davis, I now undertake to comply with your request in as satisfactory a manner as the limits of a letter will allow.

It may be proper to premise that Dr. Davis's opinions, on any medical subject, are entitled to much weight,—as to myself, from my situation as Professor of Chemistry, *&c.*, in the S. Carolina College, although once a practitioner of Physic, I am now debarred from any regular exercise of the profession, and therefore have not the opportunity of making much experimental investigation of medical subjects.

Having found in the 8th or 9th Number of the *Journal of the Royal Institution* (London,) an interesting article upon the Prussic acid by Dr. Majendie, of Paris, I pointed it out to my friend Dr. Davis, and requested him to make trial of this new remedy. A small portion was procured from Charleston, having been manufactured there by Mr. L'Herminier, an excellent French chemist, who has since returned to the West Indies; but this

being soon exhausted, no further supply could be obtained from thence, and I undertook to make it myself, which I have now several times accomplished, according to the process of Scheele, recorded in Cooper's edition of *Thomson's Chemistry*, Vol. II. p. 224, *&c.*; observing this difference, that instead of distilling one-fourth of the whole quantity of water used, I permitted but one-sixth to pass over into the receiver. This process is somewhat tedious and complicated, but with the requisite chemical knowledge, and suitable apparatus, it may be conducted with accuracy and success. Thus much for the mode of supply. As to the nature of this substance, it is a most virulent poison, and in this respect you will recognise its analogy to some of our most effectual remedies. It would therefore require to be carefully kept from common handling, and also from the action of light, which is said to decompose it. The same result ensues from long keeping; for then it exhibits a darkish blue. On its poisonous qualities, the symptoms, *&c.*, consult *Orfila on Poisons*, a valuable work lately translated and published in Philadelphia. An adult, in using it, should commence with three drops of the acid, diluted with as many ounces of water and taken in the course of twenty-four hours; a gradual increase may be made to eight or ten drops, which is the largest dose that has yet been used in this place. Our experience here is not more than of two months' standing, and during that time Dr. Davis has prescribed the acid in eight or nine cases, all of which, as yet, (with the exception of one,) have been greatly benefited. The unfortunate case was that in which it was first used, and was almost hopeless at the time; but even in this, the distressing cough, copious expectoration, and wasting hectics were for weeks kept at bay, and the patient so much re-animated as to induce a hope of recovery; but this finally proved delusive. At any rate, however, it was the best palliative that had been used, and greatly abated the sufferings of dissolving nature. From the other cases it may probably be inferred that, in proportion to the recent occurrence of the disease, has been the apparent benefit; and in no one case has the remedy produced injurious consequences. After some continuance, it appears to affect the

breast with a sense of stricture, which is relieved by its disuse for a few days, or by some discharge of blood from the lungs; or it affects the brain in a slight degree, soon removed, however, by a disuse of the medicine.

Dr. Davis has kept a regular account of some of the most remarkable cases, which I suppose may be published at some future period. The auxiliary treatment is much the same as with the use of other medicines,—to keep the stomach and bowels clear, (although the acid in some degree performs the functions of a cathartic,) to avoid alterations of temperature and exposures, *&c.* If the preceding information can be useful to you, I shall be gratified in having imparted it, and will endeavour to forward to you, by some person travelling in the stage, an ounce vial of the acid.

Should you wish to make any further inquiries upon this subject, you will please to address your letters to Dr. Davis, as I expect to leave this place on the 28th inst. for the Missouri territory, and to be absent until October next.—I am, &c.,

EDWARD D. SMITH.

2. *Medical Prize Questions.*—The following is proposed by the Society of Sciences at Haarlem. The essays should be sent to the Secretary before the 1st January, 1821.

"What advantages has medicine derived from the reformation and extension of chemistry since the time of Lavoisier, in making us better acquainted with the chemical agency of the medicines usually employed for the cure of several diseases of the human body; and what means should be taken in order to acquire a solid knowledge, useful in medicine, of the hitherto unknown chemical agency of several medicines."

The Medical Society at Paris proposes the following question. "To determine the nature, the causes, and the treatment of the convulsions which occur during pregnancy, in the course of parturition, and after delivery."

The Memoirs written in Latin or French, bearing an epigraph, repeated in a sealed billet, which shall contain the name, quality, and residence of the author, should be sent,

free of expense for carriage, to the Secrétaire Générale, before the 31 October, 1820. The prize is 300 francs.

§ Meteorology, Magnetism, &c.

1.—*On the Cold which occurs at Sun-rise, and on Nitre in Plants.*

Oxford, 10 *April,* 1820.

Sir,—I observe in your last Number an allusion to the cold usually experienced in *India*, about the time of sun-rise. As this phenomenon, or something very nearly resembling it, takes place in this country also, and, as far as I have been able to ascertain, in all others, it has often been a matter of surprise to me that its causes should have been little, if at all, investigated. The Meteorological Diary which appears in your Journal, and all that I have ever seen, state the height of the thermometer at a certain fixed *hour*, without any regard to the situation of the sun: now it appears to me that an accurate account of the thermometer at a certain *period of the day*, (viz., the morning dawn,) and a comparison of its indications then and at noon, or some fixed hour, or at one hour before and one after, would tend to throw some light on the causes of the phenomenon in question. It is one to which I have paid considerable attention for a good many years, and have never been able to obtain a satisfactory solution. It is very striking, and has been noticed by many; but their observation of it being in general very limited, they, for the most part give an incorrect, because a partial, description of it; *e. g.* some speak of a certain fixed hour as the coldest in the twenty-four: this is true during, perhaps, about one month in the year, and no longer, *viz.*, when that hour happens to coincide with the *day-break:* the case is much the same with those who fix upon half an hour before sun-rise; which may or may not coincide with the point in question.

The phenomenon, according to the best observations I have been able to make, and which I think will be confirmed by the regular inspection of a thermometer, is this: at the first dawning of morning twilight, or within twenty minutes at the utmost, of that point, a *sudden* diminution of temperature

takes place, by no means necessarily preceded by any gradual diminution: the degree of this is very various, but frequently so considerable as to make the difference between what would generally be called very mild weather, and a pretty sharp frost. I think I have on some occasions experienced in little more than twenty minutes, a change which could hardly be less than 20°. The hoar-frosts of spring and autumn generally come on at that time, and sometimes so suddenly as to surprise the earth-worms, (which come out only in very mild nights,) and freeze them in great numbers. The cold will frequently continue, for an hour or two after the sun is up, to be greater than it had been in the night. In the remarkably hot summer of 1818, all the dew that fell was at that time; the grass being at midnight as dry as at noon.

I shall be happy if these few hints have the effect of turning the attention of the lovers of meteorology to an interesting subject which has not hitherto been sufficiently investigated.

While my pen is in my hand, I cannot forbear suggesting to your chemical correspondents the inquiry, (which, if it has ever been satisfactorily pursued, I have not been fortunate enough to see the result of,) into the formation of nitre in plants: it is well known that the *juices* of some plants contain nitrate of potash; (among others, I have detected it in the polygonum bistorta, called in English " red-legs," which, as far as I can learn, had not been previously known to contain it,) but the most remarkable circumstance is its appearance in the *ashes* of a plant in which, before burning, there are no traces of it. The plant is the common yarrow or milfoil, (" Achillæa millefolium,") a strong decoction of which I ascertained to be perfectly destitute of nitre; while a part of the same parcel of the plant, on being slowly burnt, afforded ashes very strongly impregnated with it. The chemical Professor of this University will attest the fact, in case any doubt should be entertained. It is hardly necessary to remark how much light a course of careful experiments on this point would throw upon the mysterious subject of the formation of nitre.

I am, &c. &c. OXON^s.

2. *Heat at Bagdad.*—On the 26th of August of last year the thermometer, at Bagdad, rose, in the shade, to 120° Fahrenheit, and at midnight was 108°; many persons died, and the priests propagated a report that the day of judgment was at hand.

3. *Evaporation of Ice.*—The *Monthly Magazine* for April contains some observations on the *Absorption of Ice by the Atmosphere*, made by Mr. Holdsworth. Though the loss of weight of ice by evaporation is very generally known, yet there are not many experiments registered that have been made on it, and as the two following by Mr. Holdsworth, were on a moderately large scale, they will be interesting to those who engage in meteorological investigations :—" On the 28th November, 1814, being at that time about the middle of the east coast of Lake Wenepie, in lat. 52° N., I hung up in an open shed, where it was freely exposed to the air, but where the sun had no access, a flat slate of ice, about two inches thick, which weighed accurately in the steelyard 20lb. To ensure accuracy, no one but myself had admission to the building. On February 14th, it had sustained a loss of 17oz., the highest temperature in the interval being 23°. As the loss of weight was more than I expected, I again weighed it on the 20th, and found the deficiency 20oz., the highest temperature from the 14th to the 20th being 14°. Beyond this time, the experiment was not so satisfactory, the thermometer having indicated, on the 26th and 28th of February, a temperature of 36°, for upwards of two hours each day. No dropping, however, took place from the ice, nor could I perceive the least moisture upon it. In March, the thermometer was uniformly below freezing, the average temperature in the middle of the day being 14°. On the 7th of that month, the ice had lost 2¼lb.; and on the 31st, its total loss was 4lb., or a fifth part of its weight."

The next experiment was on snow. It was placed in folds of crape. It was hung up on February 16th, in the same place, the snow and its covering weighing 30oz. In ten days, it had lost 2oz.; and in the next nine days, 2oz. more. On the 14th

of March, the total loss was 6oz., or a fifth part in twenty-six days, during the whole of which time the crape had remained perfectly dry.

4. *Nature of Hail.*—M. Delcros has published the idea that hail generally, and especially when small, is composed of the fragments of crystalline spheres of ice. During ten years' observation, he had observed that the particles of hail were spherical pyramids, varying in size, but having the same form. The apex had sometimes disappeared, but when present was apparently part of a hard nucleus ; next to this came another and larger portion, radiated from the apex as a centre, and this was covered on the side opposite to the apex by a drusy portion of ice. From the constancy of these appearances, he concluded that, in the production of hail, a nucleus, composed of concentric spheres, was first formed, on which a second radiated formation was superposed, and that these masses were then broken into pieces by a kind of explosion.

In a storm which happened at la Bacconière, in the Department of Mayenne, in France, on the 4th of July, 1819, M. Delcros had an opportunity of observing these spheres, the fragments of which he supposes generally form hail. The hail-stones which fell at that time were very large, some of them being 15 inches in circumference, and they were globular. When broken they consisted of a very small nucleus, round which a larger had formed, and then this again was surrounded by a very compact radiated ice, more transparent than the rest ; the surface exhibited the appearance of pyramids ranged one by the side of another. *Biblioth. Univer.* 13. p. 154.

5. *Recession of the Magnetic Needle.*—Col. Beaufoy is induced to believe, from his Magnetical Observations, which are published in Thomson's *Annals*, that the greatest variation of the compass has been attained, and that the needle is now slowly retrograding, and returning towards the North Pole. During the last nine months of 1818, the variation gradually increased, and was in the morning 24° 37′ 4″, and at noon 24° 41′.

20″. It fluctuated during January 1819, decreased in February, and again fluctuated in March. Since that time the mean monthly variation has decreased continually, and Col. Beaufoy therefore places the maximum of western declination about the month of March 1819.

6. *Earthquake in Cork.*—An earthquake was felt between two or three o'clock in the morning of Tuesday, April 11, at Cove, Ahada, Midleton, and the neighbourhood of the harbour's mouth. It lasted about eight or ten seconds at Cove, accompanied with the rumbling noise. The agitation appears to have been much stronger at Haulbowline island. At Ahada the noise resembled the firing of cannon.

7. *Prize Question.—Variation of the Compass.*—The Royal Academy of Copenhagen proposes the following prize question: "Nùm inclinatio et vis acus magneticæ iisdem, quibus declinatio diurnis variationibus sunt subjectæ? Nùm etiam longiores, ut declinatio, habent circuitus? Nùm denique has variationes certis finibus circumscribere possumus?" The prize is 50 Danish ducats.

8. *Animal Magnetism.*—The Royal Academy of Sciences at Berlin have proposed animal magnetism as a prize subject, essays on which are to be rewarded in August 1820. It is desired that the phenomena, known by the name of animal magnetism, be described so as to admit of a positive judgment respecting their nature: and it is observed that, though there are many difficulties attached to the subject, still it appears that the number of facts ascertained is such as to admit the hope that, in the present state of the physical sciences, some light may be thrown on animal magnetism, when the probability of these facts has been estimated, and when their analogy with the better-understood phenomena of natural sleep, dreams, somnambulism not magnetic, and many nervous affections, has been established.

It is suggested to the candidates, that wonderful relations are not required, but a description of those constant laws which

magnetism is subject to, and the connexion which it has with other natural phenomena. The academy also would be glad to receive essays on the medical properties of magnetism.

The prize is 300 ducats, and no memoirs can be received after the 3d of August, 1820.

9. *Fall of a Glacier.*—On the 27th of December, at six o'clock in the morning, an enormous portion of the glacier of Weisshorn, in the valley of St. Nicholas, or Vispach, fell from its exalted situation into the valley, causing dreadful devastation amongst the cultivated grounds and habitations. At the moment when the ice and snow struck the masses lying beneath, the minister of the place, and many other persons, observed a strong light, which immediately disappeared, and gave place to utter darkness. This phenomenon, from the brightness of the light, and the number of persons who saw it, can scarcely be considered as illusory. It was probably an electrical or phosphorescent effect. The mass of ice and snow covered a space of 2,400 feet in length, 1,000 feet wide, and at a mean 150 feet in height, and the displacement of the air by it was such as to cause a hurricane, which destroyed houses, mills, and buildings, even to the distance of a quarter of a league from the place of the fall. Extreme fears are entertained for the remains of the village of Ronds, which stands opposite the glacier, for the upper part of the glacier, left unsupported by the part which has given way, threatens to fall and complete the distress which has been brought upon the inhabitants of the valley.

IV. General Literature.

1. *Literary Prize Question, Amsterdam.*—The third class of the Royal Institution of Belgium has published a programme, containing the following subject: " Prose and poetry have between them many analogies and many differences. Point out which are qualities common to both, and which are those essential to, and exclusively belonging to, each?" The prize will be 300 florins, or a gold medal of equal value. Any work sent to the sitting which may appear to merit the second prize, will be printed by the Institution. The works may be written in Latin,

Dutch, English, French, or German, and are to be sent in before the close of this year (1820.)

The following subject was proposed in 1817, but without effect. It is again published by the class: "What were the rights, the authority, and the dignity of the Roman Jurisconsulates, from the time of Augustus, to the death of Justinian? and what their influence on public administration, private rights, and the administration of justice?"

2. *Printing in Otaheite.*—M. Turgenieff, counsellor of state, has made a report to the Bible Society of Petersburgh, in which it is stated that the English missionaries have established a press at Otaheite, at which 3,000 bibles have been printed. They were all sold in the space of three days, for three gallons of cocoa-nut oil each. The books of Moses, translated into the Otaheitean language, have been printed at the same press; also a catechism for the use of the inhabitants. These have been distributed gratuitously.

3. *Literature in New South Wales.*—At Sydney, in New South Wales, there are at present three public journals, and five other periodical publications. A second printing office has also been established lately at Port Jackson. They now export cattle to the Isle of France, and the market at Sydney is considered as plentiful in the different commodities of Europe, as well as of India and China.

4. *New Arabic Grammar.*—A grammar of the Arabic language is preparing for the press by James Grey Jackson, Professor of Arabic, and late British Consul at Santa Cruz, in South Barbary. No accurate grammar of the Arabic language having yet issued from the British press, an attempt will now be made to supply this deficiency in oriental literature.

5. *Oxford and Cambridge Universities.*—It appears by a summary of the Members of the Universities of Oxford and Cambridge, in their Calendar for 1819 and 1820, that the following is the number :—

Oxford.

1819.	Members of Convocation	1874.
	on the Books	3984.
1820.	of Convocation............	1873.
	on the Books	4102.

Cambridge.

1819.	Members of the Senate	1495.
	on the Boards	3698.
1820.	of the Senate	1558.
	on the Boards	3395.

6. *Prospectus of an Expedition into Africa.*—The advancement of science, the progressive discovery of the geography, the natural history, the customs, the antiquities, the historical traditions of the interior of Africa, and the acquiring of the requisite knowledge for ameliorating the condition of its inhabitants, are objects into which neither national nor political animosities are entered, wherein every feeling subsides but that of an universal and disinterested benevolence, and for which the same generous zeal animates all nations, all parties, all institutions, all classes of society.

Governments, discouraged by so many calamitous disappointments, and reluctant to risk a further waste of public money, and the lives of valuable subjects, conscientiously suppress their anxiety for the advancement of these important objects; perhaps fortunately for the character of Europe and the happiness of Africa; for the enterprises of discovery of a government, however peaceably and legitimately planned, are, sometimes, by the ambition or impetuosity of those to whom they are consigned, perverted into aggression and assumption, and the small force which is afforded to protect, may perhaps be used to injure.

The harmless, simple enterprises, originated by individuals, admit of no offence to the laws of nature, or to the laws of nations, but peaceably benefit both science and humanity; witness the illustrious exertions of the African Association of England. It is desirable that the emissaries of such societies, that the representatives of such honourable feelings, should

precede the self-interested trader, or the daring adventurer, to establish the benevolent character of Europeans in the hearts of the Africans, by first impressions.

The world has an erroneous impression of the sum necessary for these most promising missions into the interior of Africa. The mission to Ashantee did not cost 1,500*l.* sterling money, including expensive presents, some mismanagement at the outset, much inexperience, and the protracted maintenance of nearly 100 followers. Seven hundred pounds would ensure further progress towards the Niger, and a handsome supply of instruments for observations in physical science in general, and for those of the earth's magnetism, and the pendulum in particular. The museums of Europe, by furnishing very frugal means in the requisite articles of exchange, might enrich their collections immensely, and enable the individual undertaking the enterprise, to make the world thoroughly acquainted with the natural history of Western Africa.

I invite the institutions and individuals of Europe in general, by subscribing for shares of 5*l.* each, to make this great object immediately practicable. I devote my services, I risk my life for the success. Treasurers will be appointed to receive the subscriptions, and I declare solemnly in the face of Europe, that I will never accept any salary or remuneration from the funds collected. I will never accept recompense from individuals, or from any other than my own government.

For my zeal, I refer to the mission to Ashantee; for my qualifications, to the members of the Institute who have assisted my studies here.

The extent and direction of the enterprise must be confided to my own experience, and to circumstances, after a candid communication with a Committee of subscribers. I do not promise a dazzling and precipitous rush to the Niger, to Timbuctoo, a glance over men and nature, *en passant*, but I promise to advance to both, to procure solid advantages, and to make a firm progress in the interior, which may conduct us or our descendants throughout it.

I pledge myself, as the zealous servant of science and literature, to collect, orally and in MSS., every thing that can en-

large and illustrate our knowledge of the geography, the history, the superstitions, and the customs of the interior of Africa. I pledge myself to collect zoological, mineralogical, and botanical specimens for every Institution of Europe which may desire them. I pledge myself, not merely to multiply the observations of astronomy and physical science, which my own studies and the experience of my instructors have urged to me, but I promise gratefully to receive, and zealously to execute, the suggestions of every man of science, the commands of every society; to prove myself, as long as such a climate may spare my life, the devoted and laborious envoy of Europe, and the firm and compassionating friend of Africa.

I am the first to subscribe to the enterprise, and I will be the last to abandon it.

T. Edward Bowdich,
Conductor of the Mission to Ashantee.

T. E. Bowdich, Esq. ...... 1 share *5l.*

7. *New Voyage of Discovery in the North.*—Letters from Petersburgh, dated March, state that a new voyage of discovery will be undertaken this summer in the North. The expedition will sail from the mouth of the Lena, for the Frozen Ocean, in order to examine the coast of Siberia and the islands which were discovered to the north of it some years ago. As it is not yet ascertained whether these supposed islands may not be one main land or not, and as hitherto they have only been visited in winter, it will be interesting to know how far the ice will permit vessels to advance during summer, and to determine its extent.

8. *Expedition of Discovery in America.*—The Gazette of St. Louis (on the Missouri, United States), announces the equipment of an expedition, the object of which is to ascertain the existence of a race reported to be the descendants of certain Welch emigrants. It is intended to comprehend all the southern ramifications of the great river Missouri within the limits of the excursion. This undertaking is confided to Messrs. Roberts and Parry, both Welchmen, and well acquainted with the language of both North and South Wales.

Art. XV. METEOROLOGICAL DIARY for the Months of March, April, and May, 1820, kept at Earl Spencer's Seat at Althorp, in Northamptonshire. The Thermometer hangs in a North-eastern Aspect, about five feet from the ground, and a foot from the wall.

For March, 1820.

		Thermometer		Barometer		Wind	
		Low	High	Morn.	Eve.	Morn.	Eve.
Wednesday	1	33	43	29,38	29,41	NW	W
Thursday	2	32	34	29,91	29,91	NNW	NW
Friday	3	25	37	29,60	29,80	NW	NW
Saturday	4	24	39	29,90	29,88	NW	NW
Sunday	5	22	38	30,10	30,14	NE	NE
Monday	6	27	37	30,10	30,07	NE	NE
Tuesday	7	22	39	30,07	30,03	NW	N
Wednesday	8	23	45	30,10	30,05	N	WNW
Thursday	9	34	48	30,05	29,90	W	SW
Friday	10	30	42	29,73	29,55	SE	SE
Saturday	11	27	50	29,50	29,41	SE	SE
Sunday	12	27	44	29,36	29,30	E	EbS
Monday	13	34	47	29,39	29,70	W	W
Tuesday	14	35	55	29,87	30,00	W	W
Wednesday	15	43	58	30,10	30,11	W	NW
Thursday	16	47	51	30,20	30,20	NbE	NbE
Friday	17	42	50	30,17	30,17	NW	NE
Saturday	18	33	48	30,23	30,20	NE	NNE
Sunday	19	35	45	30,17	30,12	NE	ENE
Monday	20	36	47	30,12	30,10	NE	W
Tuesday	21	30	49	30,07	29,90	W	W
Wednesday	22	40	50,5	29,65	29,65	W	W
Thursday	23	39	53	29,25	28,90	W	W
Friday	24	38,5	50	28,93	28,84	W	NW
Saturday	25	30	50	29,07	29,40	NW	NNW
Sunday	26	28	47	29,56	29,47	SW	W
Monday	27	39	55	29,57	29,59	WbS	SW
Tuesday	28	38	56,5	29,73	29,80	SW	SW
Wednesday	29	46	59	29,87	29,87	SW	SW
Thursday	30	37	60	29,80	29,84	W	NW
Friday	31	30	62	29,87	29,80	NW	SW

For April, 1820.

		Thermometer		Barometer		Wind	
		Low	High	Morn.	Eve.	Morn.	Eve.
Saturday	1	35	57	29,80	29,80	W	W
Sunday	2	42	59	29,89	29,89	SW	NW
Monday	3	41	64	30,00	30,00	WbN	E
Tuesday	4	38	62	29,90	29,70	E	SE
Wednesday	5	35	66	29,70	29,50	E	SW
Thursday	6	44	54	29,28	29,20	SW	SW
Friday	7	35	51	29,27	29,30	WbS	W
Saturday	8	31,5	52	29,28	29,16	WbS	SE
Sunday	9	40	50,5	29,19	29,30	WbN	W
Monday	10	30	52	29,36	29,22	W	SE
Tuesday	11	39	57	29,30	29,50	S	WSW
Wednesday	12	41	58	29,57	29,70	SW	W
Thursday	13	46	54	29,72	29,70	E	E
Friday	14	46,5	49	29,57	29,50	E	SE
Saturday	15	35	61,5	29,60	29,72	W	W
Sunday	16	34	63	29,90	30,00	SW	W
Monday	17	45	66	30,06	30,06	W	NW
Tuesday	18	45,5	69	30,05	29,98	NW	W
Wednesday	19	47	71	30,01	29,96	W	W
Thursday	20	45	66	29,96	30,05	W	NW
Friday	21	36	69	30,13	30,13	W	W
Saturday	22	375	67	30,18	30,22	SE	E
Sunday	23	40	64	30,37	30,39	E	EbN
Monday	24	39	60	30,40	30,40	NE	NE
Tuesday	25	37	61	30,39	30,20	NE	NE
Wednesday	26	35	62	29,90	29,60	WbS	W
Thursday	27	41	44,5	29,60	29,76	NE	N
Friday	28	29	58	29,85	29,88	NW	W
Saturday	29	35	62	29,90	29,91	WbS	W
Sunday	30	45	63	30,03	30,15	NW	WbN

For May, 1820.

		Thermometer		Barometer		Wind	
		Low	High	Morn.	Eve.	Morn.	Eve.
Monday	1	33	61,5	30,16	30,19	NW	NW
Tuesday	2	38	65	30,15	30,02	E	NE
Wednesday	3	39	52	30,02	29,97	E	E
Thursday	4	40	53	29,90	29,79	E	EbN
Friday	5	27	57,5	29,78	29,78	NE	E
Saturday	6	32	61	29,78	29,61	SW	SW
Sunday	7	44	61	29,50	29,53	W	W
Monday	8	48	61,5	29,54	29,50	SW	SE
Tuesday	9	51	65	29,47	29,50	SE	SW
Wednesday	10	44	66	29,60	29,60	S	SW
Thursday	11	48	70	29,75	29,75	SW	SW
Friday	12	46	72	29,80	29,89	SW	W
Saturday	13	37,5	71	29,89	29,78	SW	SE
Sunday	14	52	67	29,75	29,68	WbS	SE
Monday	15	42	70,5	29,66	29,66	SW	W
Tuesday	16	41	60,5	29,59	29,58	S	WbS
Wednesday	17	48,5	67	29,59	29,59	WSW	SW
Thursday	18	48	56	29,28	29,00	E	W
Friday	19	45	68	29,40	29,67	WbS	W
Saturday	20	47	68,5	29,90	30,10	W	W
Sunday	21	46	72,5	30,18	30,14	WbS	S
Monday	22	45	75,5	30,10	30,00	SE	SE
Tuesday	23	45	80	29,94	29,80	E	ESE
Wednesday	24	50	76	29,66	29,65	ESE	WSW
Thursday	25	48	66	29,60	29,57	SW	WbS
Friday	26	44	70,5	29,65	29,63	SW	SW
Saturday	27	52	68	29,56	29,48	W	W
Sunday	28	49	66	29,46	29,30	WSW	SSW
Monday	29	46	68,5	29,29	29,22	WSW	SW
Tuesday	30	43	62	29,20	29,20	SW	SW
Wednesday	31	45	66	29,23	29,25	W	W

SELECT LIST OF NEW PUBLICATIONS,

DURING THE LAST THREE MONTHS.

AGRICULTURE.

An Inquiry into the Causes of the Progressive Depreciation of Agricultural Labour in modern times, with Suggestions for its remedy. By John Barton. 8vo. 4*s.*

ARCHITECTURE AND THE FINE ARTS.

Principles of Design in Architecture, traced in Observations on Buildings. 8vo. 7*s.*

The Italian Schools of Painting; with Observations on the present State of the Art. By the Rev. T. James. 8vo. 9*s.* 6*d.*

A Catalogue of the Pictures at Grosvenor House, London; containing Etchings of the whole Collection, and an Historical Notice of each Picture. By John Young, Keeper of the British Institution. 4to. 2*l.* 2*s.*—India Paper, 3*l.* 3*s.*

A Series of Twenty-one Plates, to illustrate Lord Byron's Works. Engraved by Charles Heath, from the Drawings of R. Westall, R. A. With a Portrait. 4to. 3*l.* 3*s.*—8vo. 2*l.* 2*s.*—f. c. 8vo. 1*l.* 10*s.*

The Practice of Drawing and Painting Landscapes from Nature, in Water-colours, exemplified. By George Nicholson. 4to. 21*s.*

Notices illustrative of the Drawings and Sketches of some of the most distinguished Masters, in all the principal Schools of Design. By the late Henry Revely, Esq. 8vo. 12*s.*

BOTANY.

Rosarum Monographia: or, a Botanical History of Roses. By John Lindley, F.L.S. 8vo. 16*s.* Plain.—21*s.* Coloured Plates.

CHEMISTRY, NATURAL HISTORY, AND NATURAL PHILOSOPHY.

A Catechism of Chemistry; containing a concentrated and simple View of its elementary Principles. By an Amateur. 12mo.

The Rudiments of Chemistry, illustrated by Experiments and Engravings, with an Appendix, containing an Account of the late Chemical Discoveries; by S. Parkes, F.L.S. 5*s.*

Taxidermy, or a Treatise on the Art of preparing, mounting, and preserving every Object of Natural History for Museums; to which is added, for the convenience of Travellers, a succinct Series of more simple Instructions, for collecting, transporting, and observing the various Objects of the Three Kingdoms, with Lists indicating those which are rarest or most wanting in European Collections. In 12mo. with plates. 7*s.* 6*d.*

Geology.

A Geological Map of England, coloured: accompanied by a Memoir; to which is added an Alphabetical Index of the Hills, with a List of the Hills, arranged according to the Counties. By G. B. Greenough, Esq., President of the Geological Society. On six sheets, *6l. 6s.*—or *7l.* 10*s.* mounted on rollers or in a case.

A new Geological Map of England and Wales, reduced from Smith's Map, exhibiting a general View of the Stratification of the Country. 14*s.*

Mathematics.

The Elements of Euclid. By Alexander Ingram. 8vo. 8*s.*

Medicine, Anatomy, and Surgery.

Pharmacologia: or the History of Medicinal Substances; with a view to establish the Art of Prescribing, and of Composing Extemporaneous Formulæ, upon fixed and scientific principles. By J. A. Paris, M.D. F.L.S. 8vo. 15*s.*

An Historic Sketch of the Causes, Progress, Extent, and Mortality of the contagious Fever, epidemic, in Ireland, in the years 1817-18-19. By Wm. Hartz, M.B., Physician to the King's Hospital and to the Prisons, in Dublin. 8vo. 8*s.*

Practical Observations on the Diseases of the Lower Intestines. By John Howship. 8vo. 8*s.* 6*d.*

First Lines of the Practice of Surgery. Vol. II. By John Cooper. 8vo. 15*s.*

Lectures on the Natural History of the Teeth. By L. S. Parmey. 8vo. 5*s.*

A Treatise on Infantine and Adult Rickets; with some Remarks on Nursing, as connected with this disease. 12mo. 5*s.* 6*d.*

An Exposition of the Elementary Principles specially concerned in the Preservation of Healthiness, and the Production of Distempers among Marines. By Andrew Simpson, 8vo. 18*s.*

Letters on the present State of the Practice of Physic and Surgery. 8vo. 3*s.* 6*d.*

A Treatise on Uterine Hæmorrhage. By Duncan Stewart, Physician Accoucheur to the Westminster Dispensary. 8vo. 6*s.*

A Sketch of the Œconomy of Man; by Whitlock Nicholl, M.D., M. R.S, &c. 8vo. 10s.

A History of the Epidemic Fever, which prevailed in Bristol, during the years 1817, 1818, and 1819, founded on Reports of St. Peter's Hospital and the Bristol Infirmary. By James C. Pritchard, M. D.

Medical Notes on Climate, Diseases, Hospitals, and Medical Schools in France, Italy, and Switzerland. By James Clark, M. D. 8vo.

Medical Hints, designed for the use of Clergymen, and others, in places where professional Advice cannot be immediately obtained. Small 8vo. 2*s.* 6*d.*

Cases of Tic Douloureux successfully treated. By Benjamin Hutchinson, Member of the Royal College of Surgeons of London, &c. 8vo. 3*s.* 6*d.*

A Treatise on the Nature of Scrofula, in which an attempt is made to account for the Origin of that Disease, on new Principles, illustrated by various Facts and Observations, explanatory of a Method for its complete Eradication, &c. By William Farr, Member of the Royal College of Surgeons, London. 8vo.

An Inquiry into Certain Errors relative to Insanity, and their Consequences, Physical, Moral, and Civil. By George Man Burrows, M. D. F. L. S. &c. 8vo. 12*s.*

Veterinary Medicine.

An Account of the various Modes of Shoeing Horses, employed by different Nations. More particularly a Comparison between the English and French Methods. With Observations on the Diseases of the Feet, connected with Shoeing. By Joseph Goodwin, Esq., Veterinary Surgeon to His Majesty, and Member of the Royal College of Surgeons. With Plates, 8vo. 12*s.*

Miscellaneous.

The Edinburgh Encyclopædia; or Dictionary of Arts, Sciences, and Miscellaneous Literature. Conducted by David Brewster, L.L.D., F.R.S. 4to. Vol. XIV. Part I. 1*l.* 1*s.*

Biography.

The authentic Life of Augustus Von Kotzebue, from the German. 12mo. 7s. boards. Containing many interesting Anecdotes illustrative of his Character, the influence of his Writings upon Society in Germany, &c. &c.

Political Economy.

Principles of Political Economy. By the Rev. T. R. Malthus, M. A. 8vo. 18*s.*

Reply to an Article in the last Edinburgh Review, entitled Parliamentary Inquiry. By John Davison, B. D. 8vo. 3*s.* 6*d.*

A Treatise on the Practical Means of employing the Poor, in Cultivating and manufacturing Articles of British Growth, in lieu of Foreign Materials. By William Salisbury, 8vo. 2*s.*

An Analysis of the true Principles of Security against Forgery. By Sir William Congreve, Bart. M. P. 8vo. 1*l.* 1*s.*

Russian Tarif, for 1820, containing all the Duties of the Russian Empire.

Topography (English).

A Picture of Margate. By W. C. Oulton. 20 plates. 8vo. 9*s.*

The Guide to all the Watering and Sea-Bathing Places, for 1820. With numerous plates and additions, 12mo. 15*s.*

A Picturesque Tour of the English Lakes. Part I. 4 coloured views and 24 pages of letter-press, Demy 4to. 6s. Large paper, 10s. 6d.

TOPOGRAPHY (FOREIGN).

A Visit to the Province of Upper Canada, in 1819. By James Strachan. 8vo. 6s. 6d.

Journals of Two Expeditions behind the Blue Mountains, and into the interior of New South Wales, undertaken by order of the British Government, in the years 1817-18. By John Oxley, Esq., Surveyor-General of the Territory and Lieutenant of the Royal Navy. With Maps and Views of the Interior, or newly discovered country. 4to. 2*l.* 10*s.*

Geographical and Descriptive Delineations of the Island of Van Diemen's Land. By Lieutenant C. Jeffreys, R. N. 8vo. 5*s.*

A Geographical, Statistical, and Historical Description of Hindostan, and the adjacent country, composed from the most authentic printed documents, and from the manuscript records deposited at the Board of Control; consisting of the official reports, and public correspondence of nearly all the most eminent Civil Servants at the Three Presidencies, and also many of the most distinguished Military and Medical Officers. By Walter Hamilton, Esq. With Maps. 2 vols. 4to. 4*l.* 14*s.* 6*d.*

A History of the West Indies. By the late Rev. Thomas Coke, L. L. D. 3 vols. 8vo. 1*l.* 4*s.*

FOREIGN LITERATURE.

Retsch's Series of Twenty-Six Beautiful Outlines to Goethe's Tragedy of Faust. 4to. 14*s.*

A few copies are printed in imperial 4to., with proof impressions, 1*l.* 1*s.*

An Analysis of the Tragedy of Faust, in Illustration of the Outlines, and printed uniform with them. 6*s.* each part. Large paper 8*s.*

El Teatro Español con notas criticas y explanatorias. Volume I. containing seven Plays by Lope de Vega and Cervantes. Price 1*l.* in Boards. Volume II. containing Five Plays by Calderon de la Barca. With a Portrait of the Author. Price 1*l.* in Boards.

La Pronunciation Angloise Rendue Facile par Analogie avec les Sons François, d'après le Système François, d'après le Système de Walker. Par John Davenport. 12mo. price 4*s.* boards.

Maillard's complete Treatise on the present and past Participles of the French Language. 3*s.* 6*d.*

Chefs-d'œuvre of French literature; consisting of interesting Extracts from the classic French Writers, in Prose and Verse, *&c.* Two Volumes. 8vo. price 1*l.* 4*s.* or in royal 8vo. price 1*l.* 16*s.*

Nouveau Recueil de Contes et Anecdotes, François-Italien. 12mo. 6*s.* in boards.

VOYAGES AND TRAVELS.

A View of the Agriculture, Statistics, and State of Society in Holland, Germany, and part of France, taken during a tour in those Countries in 1819. By W. Jacob, Esq. F.R.S. 4to. 1*l.* 15*s.*

Journal of a Tour through part of the Snowy Range of the Hìmālā Mountains, and to the Sources of the Rivers Jumna and Ganges. By J. B. Fraser, Esq. With a Map. Royal 4to. 3*l.* 3*s.*

Twenty Views in the Hìmālā Mountains, illustrative of the foregoing Travels. Engraved from Drawings made on the Spot by J. B. Fraser, Esq. To Subscribers 21*l.* To Non-subscribers, 26*l.* 5*s.*

Travels on the Continent, for the Use of Travellers; in one handsome and closely printed Volume, 8vo. 1*l.* 5*s.*

The Diary of an Invalid in pursuit of Health; being the Journal of a Tour in Portugal, Italy, Switzerland, and France, in the Years 1817, 1818, 1819. By Henry Matthews, Esq., AM., Fellow of King's College, Cambridge, 8vo. 15*s.*

Italy and its Inhabitants, in the Years 1816 and 1817. With a View of the Manners, Customs, Theatres, Literature, and the Fine Arts, with some notice of its various Dialects. By James A. Galiffe, of Geneva, 2 vols. 8vo.

An Account of Timbuctoo and Housa, territories in the interior of Africa. Translated from the Arabic of El Hage Abd Salum Shabeenie, and a native of Marocco, who personally visited and resided in those Countries. With Notes, &c. By J. G. Jackson, esq., 8vo. 12*s.*

The American Traveller's Directory; being a complete List of all the Direct and Cross Roads, and also the Conveyance by Water, throughout the United States of America. By John Melish, Geographer at Philadelphia. 8vo., 4*s.* 6*d.*

Travels in Brazil in the Years 1815-16-17. By Prince Maximilian, of Wied Nieuwied. With Plates. Part I., 2*l.* 2*s.*

Travels in Sicily, Greece, and Albania. By the Rev. T. L. Hughes. 2 vols. 4to., with Plates, 5*l.* 5*s.*

Journal of a Tour in the Levant. By Wm. Turner, esq. 3 vols. 8vo., with 54 coloured Plates, Wood-cuts, &c. 3*l.* 3*s.*

History of the Indian Archipelago, containing an Account of the Manners, Arts, Languages, Religions, Institutions, and Commerce of its inhabitants. By John Crawfurd, F.R.S. Late British Resident at the Court of the Sultan of Java. 3 large vols., with 33 Maps and other Plates, 2*l.* 12*s.* 6*d.*

Travels in various countries of the East, being a continuation of Memoirs relating to European and Asiatic Turkey, &c. Edited by Robt. Walpole, M.A. 4to., 3*l.* 3*s.* bds.

Narrative of a Journey in Persia, 8vo. 12*s.*

SCIENTIFIC FRENCH WORKS,

Recently imported by Messrs. Treuttel and Würtz.

Cuchin Mémoire sur la Dîgue de Cherbourg comparée au Breakwater ou jetée de Plymouth. 4to., 1*l.* 6*s.*

Dupin Voyages dans la Grande Bretagne entrepris relativement aux Services Publics de la Guerre de leur Marine et des ponts et Chaussées en 1816, 1817, 1818, 1819, *première partie.* Force Militaire, 2 vol. 4to., et planches, fol. 1*l.* 16*s.*

Desportes et Constancio, Conspectus des Pharmacopées de Dublin, de Edimbourg, de Londres, et de Paris. Suivi d'un Appendice extrait des Pharmacopées de Berlin, de Brême, de Copenhague, de Pétersbourg, de Philadelphie, de Stockholm, et de Vienne; contenant un Précis des propriétés et des doses des Médicamens simples et composés, et des remarques pratiques sur leur emploi, 18mo, 8*s.*

Moulin, Traité de l'Apoplexie, ou Hémorrhagie cérébrale, Considérations nouvelles sur les Hydrocéphales, Description d'une Hydropisie cérébrale particulière aux vieillards, &c. 8vo. 6*s.*

Dictionnaire des Sciences Médicales, tom. XL.—XLIII., 8vo. 10*s.* per vol.

Flore du Dictionnaire des Sciences Médicales, Livraisons, 88—99. 8vo., each 3*s.* 6*d.*

Virey, Traité de Pharmacie théorique et pratique, nouvelle édit. entièrement refondue, 2 vols. 8vo., 1*l.* 6*s.*

Borgnis, Traité de Mécanique appliquée aux Arts. Partie VII. Des machines qui servent à confectionner les étoffes, *avec* 44 *planches*, 4to., 2*l.* 5*s.*, *papier velin*, 4*l* 4*s.*

Archives des Découvertes et des Inventions nouvelles, faites dans les Sciences, les Arts, et les Manufactures, tant en France que dans les Pays étrangers, pendant l'année 1819. (12ème volume de la Collection.) 8vo., 9*s.*

Jullien, Esquisse d'un Essai sur la Philosophie des Sciences, contenant un nouveau projet d'une division générale des Connoissances humaines, 8vo., 4*s.*

Lamarck, Système analytique des Connoissances positives de l'homme restreintes a celles qui proviennent directement et indirectement de l'observation, 8vo., 8*s.*

Humboldt et Bonpland, Nova Genera et Species Plantarum, cura C. S. Kunth, Fascic XIII. et XIV. in 4to. et folio.

Mazois, Les Ruines de Pompéji, dessinées et mesurées pendant les années 1809, 10, 11. Livraison XIII. in folio, 1*l.* 11*s.* 6*d.*

Costaz, Rapport du Jury Central, sur les produits de l'Industrie Françoise, 8vo., 8*s.*

Gerionville, Histoire Naturelle des Lépidoptères, ai Papillons diurnes, des Environs de Paris. Livraison I. 8vo., with 2 fig. coloriées. 5*s.*

Fragmens d'Ornemens dans le Style Antique, recueillis ou composés par Beauvallet et Normand; ouvrage dans lequel on trouvera toutes sortes de détails relatifs à la décoration intérieure et extérieure des édifices, 2 vol., in folio, 6*l.* 6*s.*

INDEX.

A.

B.

C.

D.

E.

F

G.

H.

I.

J.

K.

L.

M.

N.

O.

S

T.

U

V

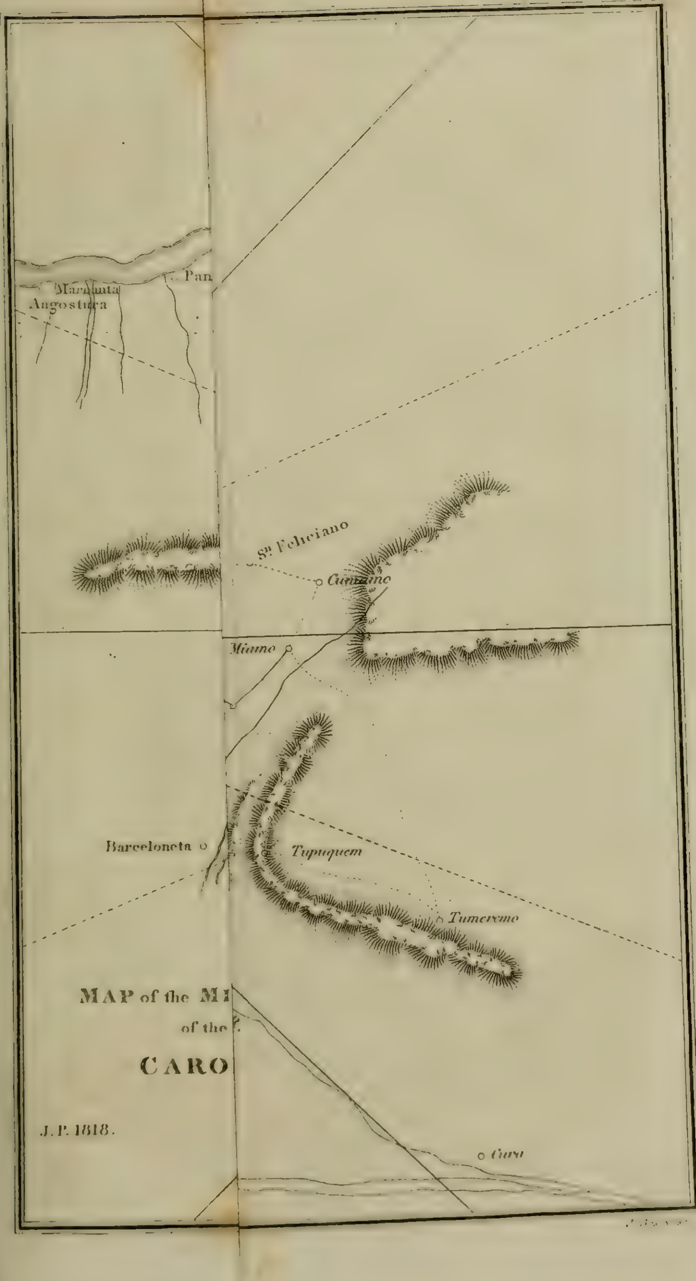
W

Y.

Z.

END OF VOL. IX.

Printed by W. Clowes, Northumberland-court.


Pan.
Marhuanta
Angostura
Sn. Feliciano
Cumamo
Miamo
Barceloneta
Tupuquem
Tumeremo
MAP of the M
of the
CARO
J. P. 1818.
Cura


MAP of the MISSIONS
of the
CARONI.
J. P. 1818.
Sn Miquel
San Felix
Wasipati
Tupuquen
Tumeremo
Barceloneta
Cayuni to the Essequibo

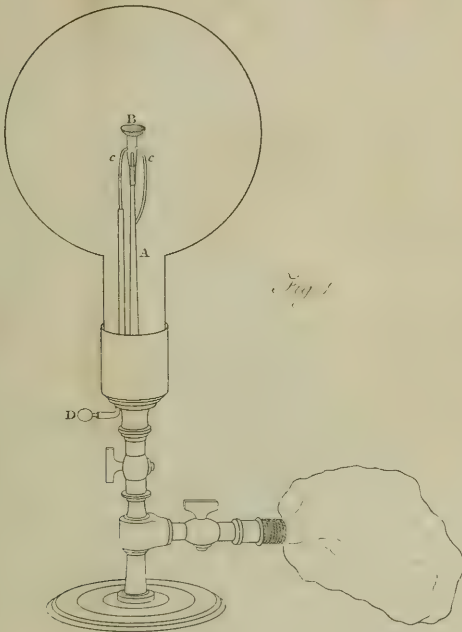


Fig. 1.

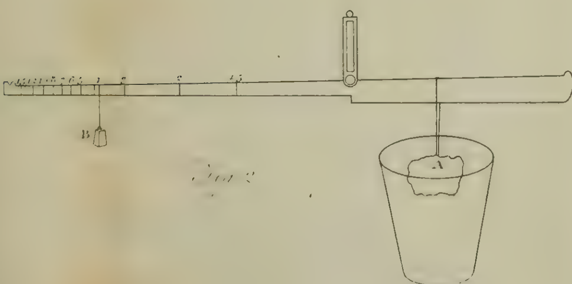
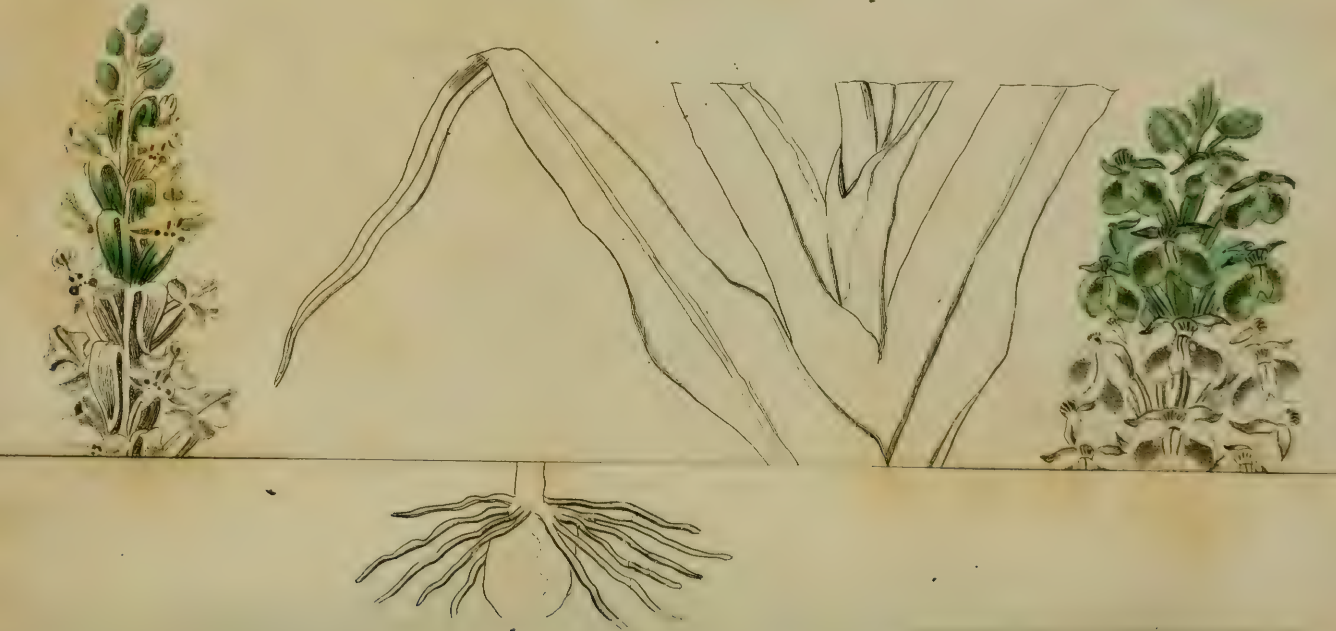


Fig. 2.

Published by John Murray Albemarle Street London 1820

J. Basire sc.

Pl. IV.



PL. IV

Vol. IX

Pterygodium Volucris

Pterygodium [illegible]